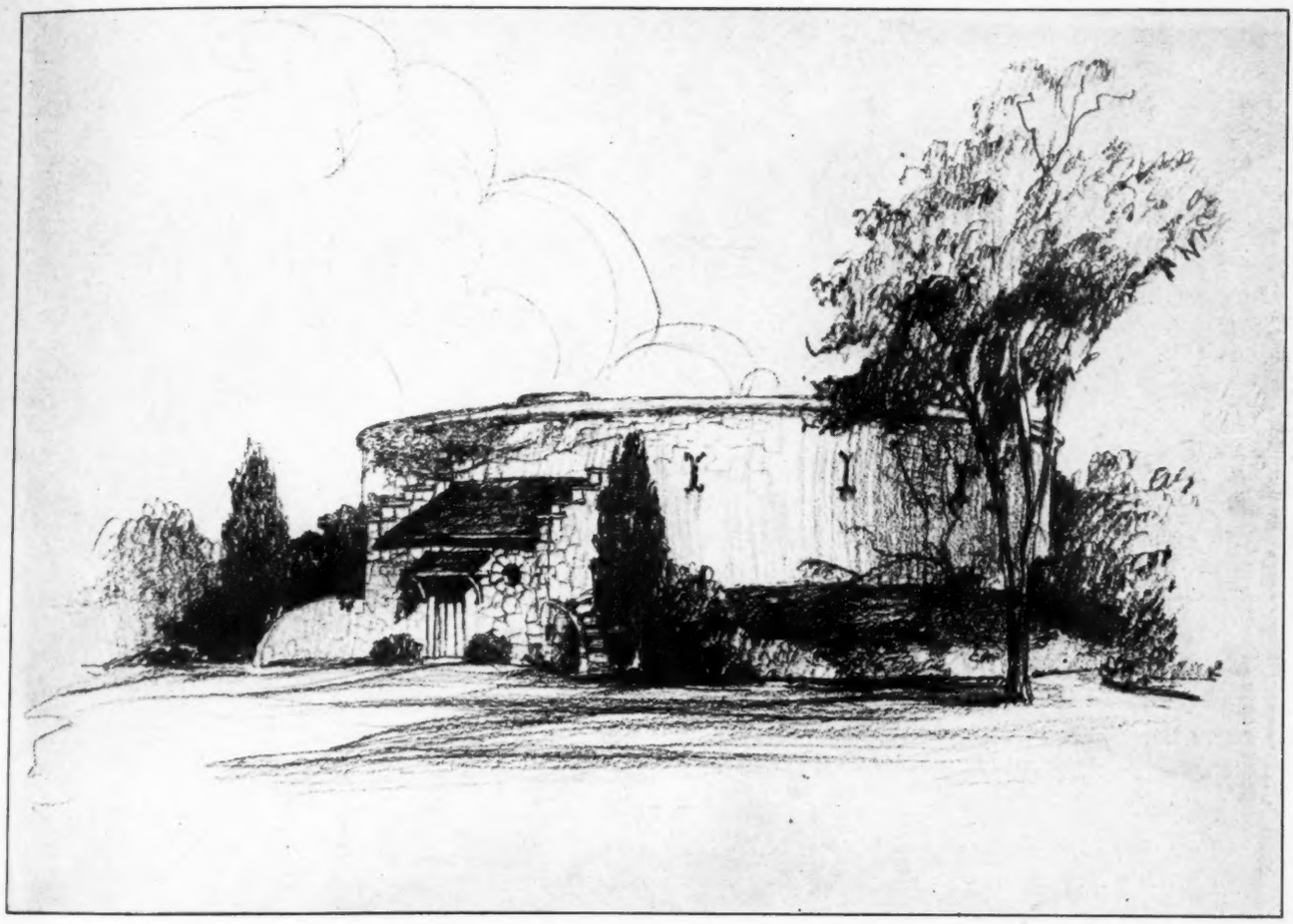
WATER WORKS AND SEWERAGE

June, 1935 — Editor — Vol. LXXXII. No. 6



Architects' Sketch of Reservoir Constructed at Eau Claire, Wis. (Greeley & Hansen, Engineers; Root & Hollister, Architects)

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Meat Packing Plant Waste Treatment
A Study of Filtering Materials for Rapid Sand Filters
Locating Ground Water Free from Iron and Manganese
Chicago Method of Making Chlorine Residual Determinations
Reports of Cincinnati Convention of American Water Works Association
Report of Meeting of Maryland-Delaware Water and Sewerage Association

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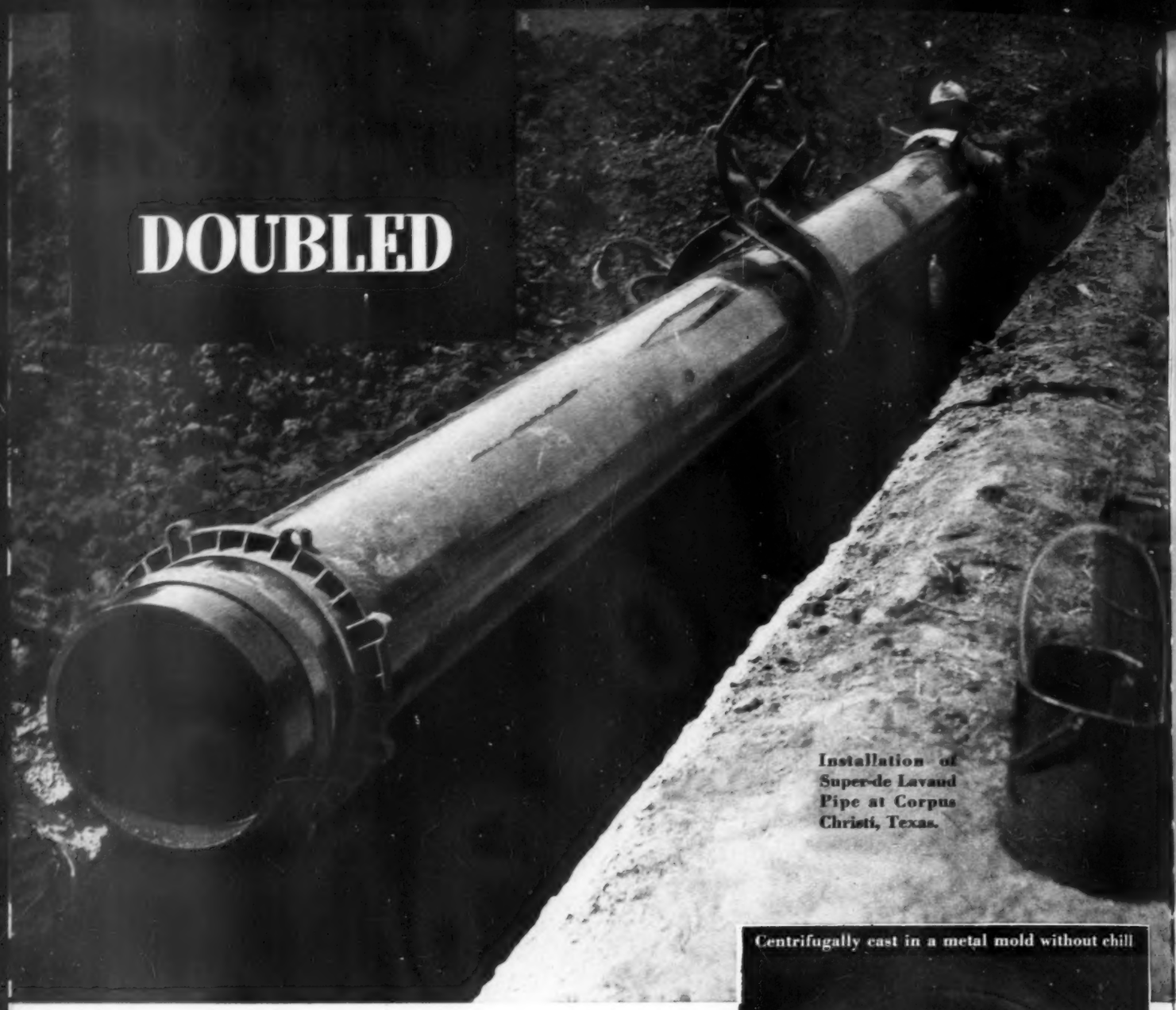

Installation of Super-de Lavaud Pipe at Corpus Christi, Texas.

CONSIDERING the historical longevity of cast iron pipe it may seem like "painting the lily" to state that Super-de Lavaud Pipe will render superservice as an underground conduit. Yet results of tests show conclusively that the *metal structure* of pipe produced by the Super-de Lavaud Process is fundamentally superior. A basic metallurgical advance is achieved by casting the gray iron in a metal mold *without chill.* The outstanding result, attested by eight million feet of Super-de Lavaud Pipe already sold and installed, is an extraordinary increase in impact-strength, without reduction of tensile and bursting strength. A booklet describing the Super-de Lavaud Process will be sent on request.

Centrifugally cast in a metal mold without chill

U.S. SUPER-de LAVAUD PIPE

CAST WITHOUT CHILL IN A METAL MOLD

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Foundries and Sales Offices throughout the United States

WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues

"Thirteen Years of Operation of the Tucson (Ariz.) Water Department" as reviewed by L. R. Burch reveals an outstanding record—financially and otherwise. It reveals what a live water-works organization has been able to accomplish in the Arizona desert under trying conditions, both natural and financial.

Mark B. Owen, Supt. Public Works, Dearborn, Mich., will describe the new Herreshoff type of incinerator installed to burn chemically precipitated sludge from the Dearborn plant. Operating results, installation and operation costs will be revealed.

"The Performance of Battery Meters" by C. M. McCord, General Superintendent, of the Memphis, Tenn. Water Department, will reveal an improved method of installing a battery of 2 inch meters instead of a single larger meter. The results of studies of the performance of meter batteries under parallel conditions with compound and turbine types of meters; for accuracy, pressure loss, etc., reveal the comparative merits of each under variable conditions existing.

"A Marble Filter for Corrosive Waters" which has proved highly beneficial in raising the pH of the well water, pumped through the marble bed, and in reducing the corrosion problem, will be described and results revealed by Henry Ryon, Sanitary Engineer, New York Department of Public Works. Especially interesting, is this scheme, for small and intermittently pumped supplies.

"Lancaster Water Works Celebrates 100th Anniversary" is the title of an article by Jas. J. Malone, Supt. of Water and Sewerage, Lancaster, Pa., which tells a bit of the history and depicts the features of the new filtration plant and other recent improvements to the Lancaster Water Works. In a later article Mr. Malone will also reveal a method of cost keeping and show the division of the Lancaster dollar of expense of operation, between production, pumpage, storage, distribution, management, etc., in a very complete and enlightening manner, involving graphic presentation on display charts.

"The Spray Drying of Sewage Sludge" is the title of a contribution from John R. Downes, which reveals operating results and operating cost data during a period of several months service of the pioneer installation of the Spray Sludge Drier which is located at the Plainfield (N. J.) Joint Sewage Treatment Works of which the author has charge.

F. M. Veatch, of Black and Veatch Engineers, will describe the new chemical sewage treatment plant of York, Neb., and cite performance records, installation and operating costs.

"Operating Experiences at the Newark, N. Y. Sewage Treatment Works" are to be revealed by Thomas J. Smith, Chief Operator of Newark's modern activated sludge plant which has many of the newest developments in plant design incorporated. Mr. Smith relates troubles and how corrected and reports the results of several measures introduced to improve plant efficiency and reduce operating costs to a figure justifying the pride manifest in the records.

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Wise pool owners everywhere are using Perchloron in their pools... also in shallow foot baths placed where the bathers will have to walk through them for preventing the spread of athlete's foot . . . as a bleach and a sterilizer in the rinse water for bath towels and bathing suits . . . and in spray and powder form as an effective deodorizer and disinfectant.

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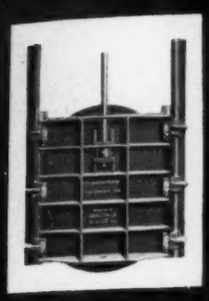
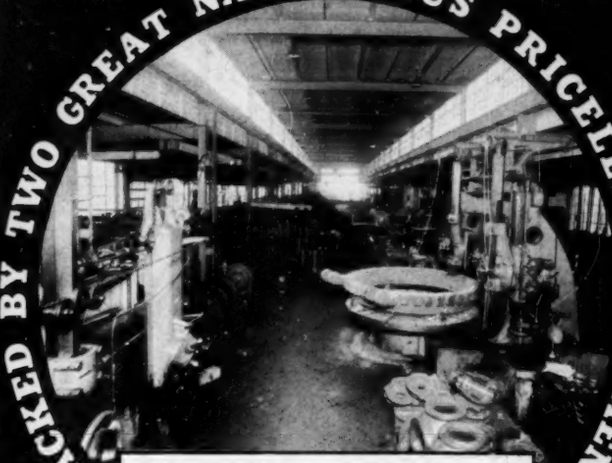
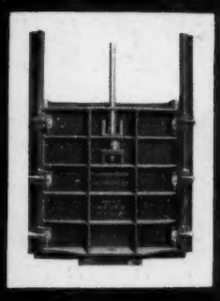




A bay of the new Columbian machine shop at Chattanooga where the finest facilities are available for building water control equipment.



Your assurance of

"THROUGH THE YEARS" DEPENDABILITY

in Water Control Equipment

THE control equipment that goes into the sewage disposal, pumping or filtration plant of today may be called upon for unfailing service a half century hence . . . that's why the sluice gate or the lowly flap valve means something more than mere cast iron to the Columbian and Mueller organizations.

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Today, at Chattanooga, an entirely new shop has been equipped with every possible facility for building sewerage and filtration plant equipment, as well as fire hydrants and gate valves of the most modern design and to the highest standards of precision manufacturing . . . your assurance of dependability through the years.

BULLETIN S-1 describes the complete line of Columbian water controlling equipment, covering sluice gates, floor stands, gate hoists, shear gates, flap valves and mud valves. ***Write for your copy.***

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Division of **MUELLER CO.**
Decatur, Illinois

COLUMBIAN

WATER CONTROLLING EQUIPMENT

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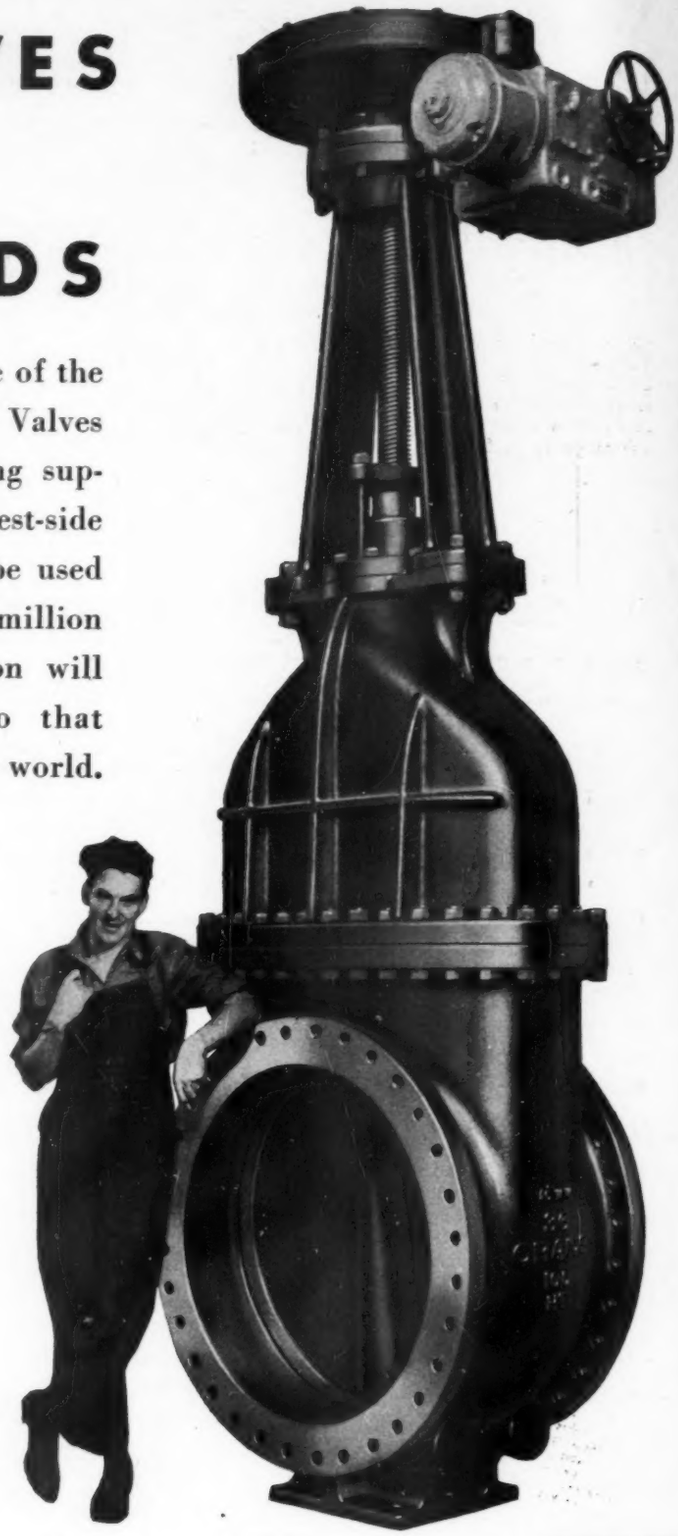

FEATURES

Motor hand-wheel stationary during valve operation. Motor always in clutched position for operation by remote control. No electrical or mechanical de-clutching device to get out of order. Torque control governs closing operation which in the event of obstruction entering valve will operate and prevent wrecking valve or straining of equipment.

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Summer Time Is Trouble Time

I have selected the above picture and headline because it brings us a realization that hot weather will soon be here, bringing with it the changing raw water conditions which always cause taste and odor troubles.

This summer prepare for these conditions early. Use AQUA NUCHAR in the mixing chamber at a dosage between 8 and 12 lbs. per million gallons to stabilize sludge and condition the filter sand. Supplement with additional AQUA NUCHAR applied to the water flowing to the filters when small traces of tastes or odors pass thru the coagulation process.

Fred G. Stuart

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Gentlemen:
We would like to receive the following:

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2—Articles on taste and odor control.
3—Treatment of open reservoirs.
4—Information on new coagulants.

Yours very truly,

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Title .....
City .....
State .....

W. S. I.

"We find use for HTH *almost daily"*

Says C. R. Wightman, Director of Public Works, City of Benton Harbor, Michigan. "We would consider our chemical stores incomplete without a goodly supply of HTH."

THE wide usefulness of HTH in water works practice is well illustrated at Benton Harbor, Michigan, where C. R. Wightman, Director of Public Works, "finds use for it almost daily." Following the statements quoted above, Mr. Wightman continues:

"During the past season we changed our plant from steam power to electricity necessitating new connections to pumps and discharge mains. We employed HTH in the disinfection of pumps and piping, with the result that the entire change was made without contamination of the water output.

"Some twenty dead ends were also connected and in every case the new pipe was disinfected with HTH. It is also used in the periodical cleaning of the clear-water reservoir and of the coagulation basins. We treat our filter beds frequently and for the past two years our output has had a zero B coli index.

"A number of the summer resorts in the vicinity of Benton Harbor having their own water systems have experienced contamination and on recommendation of our chemist have had satisfactory results from the use of HTH. One resort developed a typhoid case and traced it to their storage tank. We furnished them HTH and it cleared up immediately.

"We also use Mathieson Liquid Chlorine exclusively and find it invariably satisfactory as to uniformity and purity."

A 72-page handbook on water purification by W. L. Savell is available free of charge to city officials and engineers. This book, "Hypo-Chlorination of Water" (Second Edition), contains nearly 50 illustrations and shows up-to-date methods and equipment. It tells you what to do under both ordinary and emergency conditions —and how to do it. Send for your copy today.

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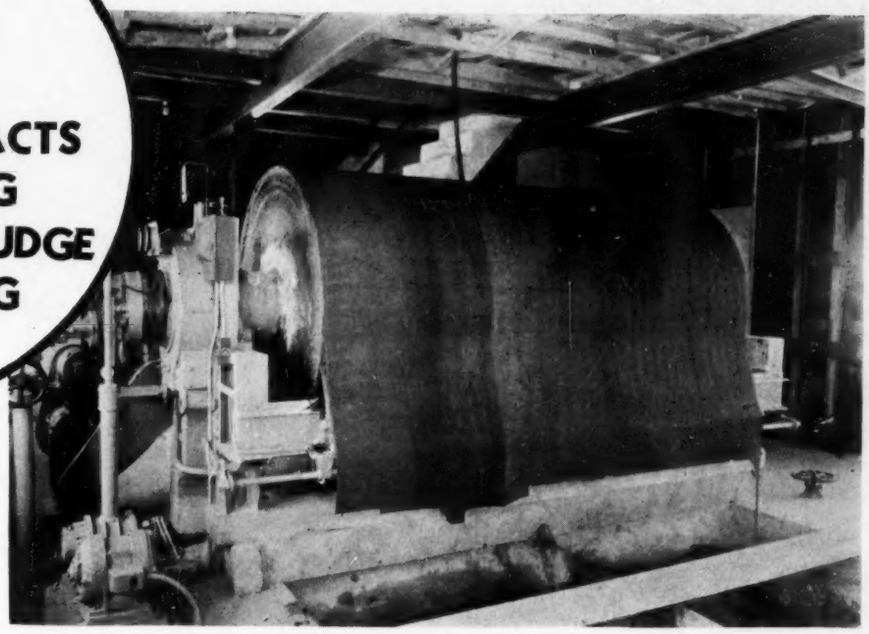
Filter house and pumping station, Benton Harbor Water Works, where HTH and Mathieson Liquid Chlorine are used regularly.

4

IMPORTANT FACTS CONCERNING MECHANICAL SLUDGE DEWATERING



Oliver United offers

1 more than 10 years' experience

2 an understanding of the problem

3 engineering proficiency

4 specialized mechanical equipment

Mechanical dewatering of sewage sludges is rapidly gaining in popularity with sanitary engineers and municipal officials because of its simplicity, cleanliness and economy. But all of this has not been accomplished overnight. Years of study and research have been applied to bring this method of sewage handling to its high state of effectiveness.

Oliver United has been the leader in this work and brings to the problem the background of many years contact and of many successful installations. The Oliver United 4-point service outlined above assures the city of the modern method of sewage sludge handling.

✠ ✠ ✠ ✠

The picture shows the Oliver Mechanical Sludge Dewaterer operating in the recently completed station at Oklahoma City, Oklahoma. There is an interesting story about this particular installation. Would you care to have the details?

OLIVER UNITED FILTERS INC.

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In the laying out of a new system or remodernization of an old one, it may prove profitable to consider the advantages of these pumps. Full information is available to engineers or responsible officials without charge. Fairbanks, Morse & Co., 900 South Wabash Avenue, Chicago. 32 Branches at your service throughout the United States.

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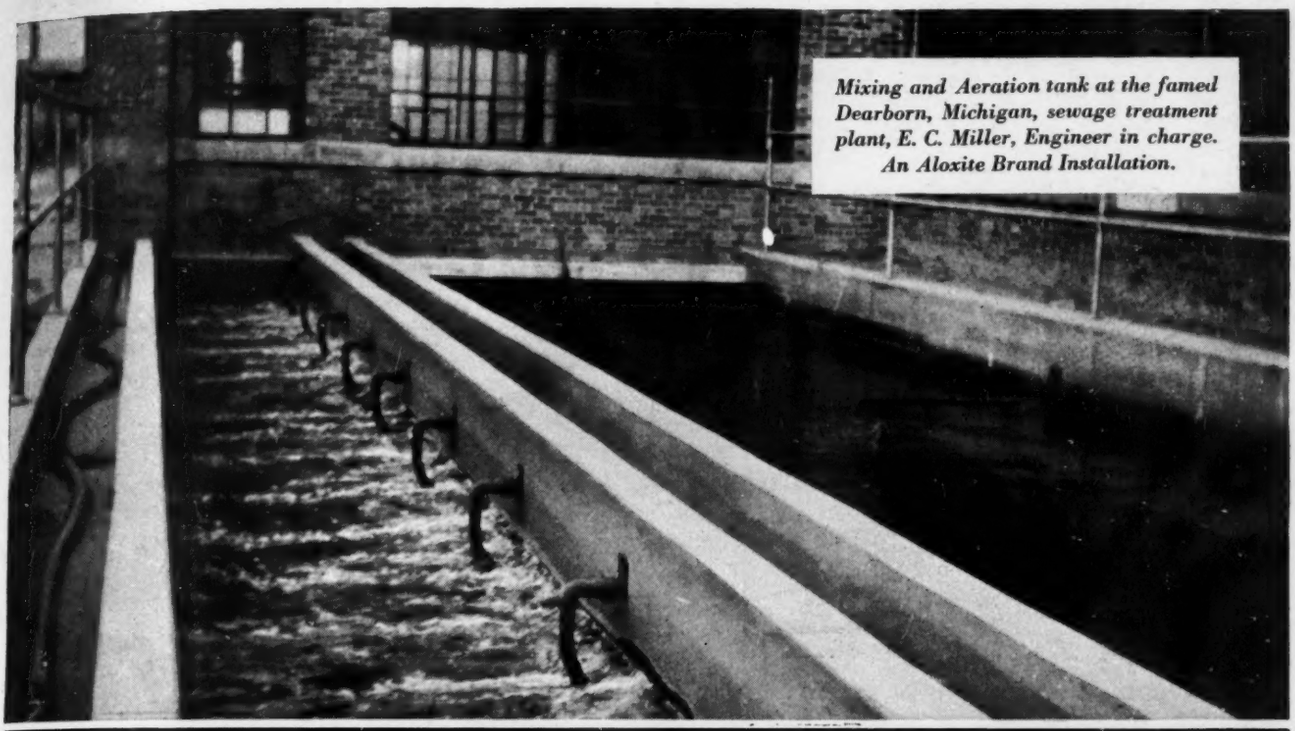
FORCEFUL FACTS ON SEWAGE AERATION BY AIR DIFFUSION—No. 7



Mixing and Aeration tank at the famed Dearborn, Michigan, sewage treatment plant, E. C. Miller, Engineer in charge. An Aloxite Brand Installation.

CHEMICAL TREATMENT OF SEWAGE UTILIZES AERATION BY AIR DIFFUSION TO GREAT ADVANTAGE

MODERN chemical treatment of sewage has been successfully established. It fills the gap between mechanical types of preliminary treatment and biological types of complete treatment. The Dearborn, Michigan installation pictured above, first of the modern chemical plants, offers an excellent example.

All processes of chemical treatment now being considered utilize aeration by air diffusion advantageously because—

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- Chemicals are maintained in their most effective (ferric) state.
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- It naturally improves flocculation of solids thus resulting in improved settling.

The period of aeration and arrangement of air diffusion depends on the process of chemical treatment adopted.

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Geo. E. Willcomb, Supervising Chemist, Albany

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FOLLOW THE BUILDERS CAMERAMAN
as month by month he shows views of interesting installations.

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Bulletin 274 — The Venturi Meter for Water Works
Bulletin 232 — Venturi Direct Acting Controllers

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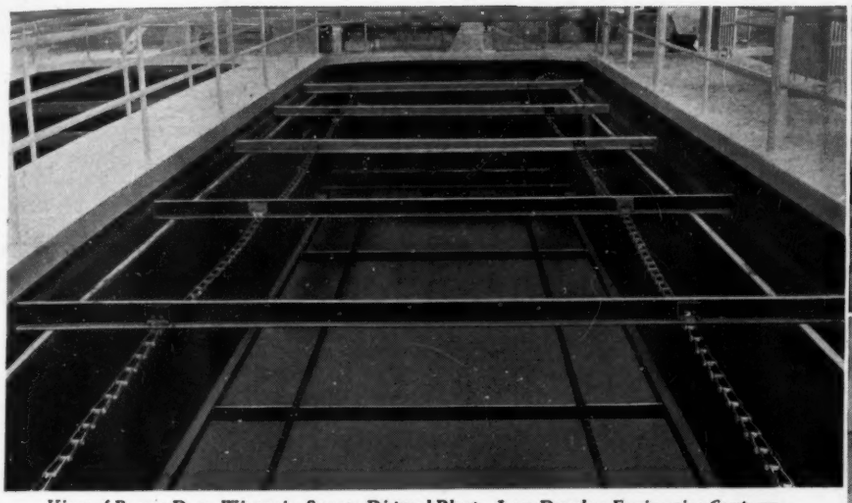

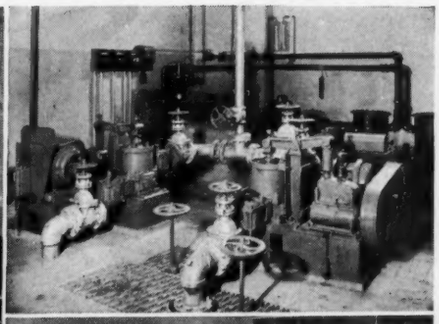

Views of Beaver Dam, Wisconsin, Sewage Disposal Plant—Jerry Donahue Engineering Company, Consulting Engineers; Mr. Arnold Kraeft, City Engineer.

Above: Primary Tank Sludge Collector, showing cross collector.
Right Top: Rex Plunger Sludge Pumps. Right Bottom: Rex Mechanically Cleaned Bar Screen.

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Rex Bar Screens, Sludge Collectors and Sludge Pumps are products of a specialized division of the Chain Belt Company that dates back to 1917.

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For freeing sewage effluents from disease spreading germs, sanitation engineers are mindful of the fact that the method of plain subsidence lags in results far behind the Intermediate Treatment for sewage disposal, using Bear Brand Ferric Chloride as the coagulant, and Bear Brand Chlorine as the sterilizing agent.

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85% to 95% of all suspended matter is removed, and B. O. D. reduced 70% to 80%:—*Its results are highly satisfactory.*

Two-stage sedimentation, without activation of sludge, is still another feature of the Intermediate Treatment:—*This means simplicity of installation and operation.*

In safeguarding public health, use only the best methods and supplies. Great Western serves you with the best.

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It follows the design of the larger Infilco feeders. The Vortex Mixer—standard equipment with the feeder—draws dust down into the water funnel and makes operation extremely clean. The attractive price brings this accurate and substantially built feeder within the reach of every water purification plant.

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Water Softening and Filtration Plants
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INTERNATIONAL

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. . . *with* STEWART FENCE

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Stewart IRON and WIRE FENCES

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The Tru-Test Sampler takes accurate representative samples of the sewage flowing through the plant by taking samples automatically in proportion to the flow. This gives samples containing the correct proportion of suspended solids and dissolved organic matter. Samples can also be taken to show accurately the changes in the character of the raw sewage during the day as well as the effectiveness of the various stages of treatment as the sewage passes through the plant.

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This 106 year old pipe *"has never given any trouble"*

It was laid in Lynchburg, Va. the year Robert E. Lee was graduated from West Point.

THIS section of a cast iron main, recently uncovered for inspection by the Water Department of Lynchburg, Virginia, is part of the second oldest existing cast iron water main in America. It went into service on July 18th, 1829. Used as a pumping main until 1882, it was in that year replaced by a larger main shown at the side and above in the photograph. Since then it has been used as part of Lynchburg's distribution system and "has never given any trouble" —a striking testimonial to cast iron pipe with bell-and-spigot joints.

The economies resulting from the long life of cast iron pipe are due to its effective resistance to rust. Cast iron is the one ferrous metal for water and gas mains, and for sewer construction, that will not disintegrate from rust. This characteristic makes cast iron pipe the most practicable for underground mains since rust will not destroy it.

4 Reasons Why Water Works Improvements Are Preferred P.W.A. Projects

1. Approximately 75% of the cost of manufacturing, distributing and installing cast iron pipe, including raw materials, goes directly to workmen.
2. Manufacturing and installing one mile of 6-inch cast iron pipe main gives approximately 1000 man-days of employment.
3. For every 100 tons of cast iron pipe manufactured, the railroads handle approximately 1000 tons of raw materials.
4. The direct and indirect employment of thousands of workmen in connection with this type of construction means a wide distribution of wages.

For further information, address The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 1015 Peoples Gas Building, Chicago, Illinois.

CAST IRON PIPE

METHODS OF EVALUATING BIDS NOW IN USE BY ENGINEERS RATE THE USEFUL LIFE OF CAST IRON PIPE AT 100 YEARS

TRADEMARK REG.

Do you mention WATER WORKS AND SEWERAGE? Please do.

WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. LXXXII JUNE, 1935 NO. 6

Architect's Sketch of Well Pump House for Eau Claire, Wis.

LOCATING GROUND WATER FREE FROM IRON AND MANGANESE

Methods Employed in Developing a Water Supply for Eau Claire, Wisc.

By A. R. GARNOCK[1] and PAUL HANSEN[2]

DEVELOPMENT of ground water for public water supplies presents complicated and interesting problems. There is such variation in ground water resources that no single experience has general applicability. One hesitates, therefore, to further burden the literature with an account of a ground water development, though interesting. Investigations at Eau Claire, however, emphasized several points that have some general applicability in searches for ground water supplies, namely: (1) A demonstration of the value of a careful study of local geology. (2) A demonstration of the value of thorough and prolonged tests of quality and yield before a permanent development is actually made. (3) The discovery that natural conditions may be favorable for the removal of iron and manganese.

Brief History of Eau Claire's Water Supply

The first public water supply was established by a private company in 1885. Water was obtained from a large dug well 60 ft. in diameter and 20 ft. deep. The water in the well, however, was so highly impregnated with iron that it was unfit for use. In 1891 the source of supply was changed to springs which contained relatively little iron but were subject to pollution and the supply was limited. The springs were abandoned when wells were sunk in bottom lands to the southward of the springs and on the same side of the river. The water supply of Eau Claire until the present new works went into operation (October 16, 1934) was from this well field.

In the supply, iron was noticeable but apparently manganese gave little difficulty and this was the condition when the water works were acquired by the city in 1909. Wells put down thereafter yielded water containing relatively large amounts of iron and manganese. A curious characteristic of the development was that there was great difference in iron and manganese content of water from wells relatively close together. The characteristics of the material penetrated by the several wells gave little clue to the cause of this difference. Some of the wells yielded water containing iron in quantities less than 0.5 parts per million while others

One of Four Pump Houses Above the Wells. (See Architect's Sketch)

[1]City Engineer, Eau Claire, Wis.
[2]Greeley & Hansen, Cons. Engineers, Chicago, Ill.

Well Drilling Rig Putting Down Permanent Wells 6 In. in Diameter

contained eight to ten times as much—i.e., 4 to 5 p.p.m. The variation in manganese content was even greater—namely, from a trace to 14 p.p.m. The iron and manganese also varied from time to time in the individual wells and appeared to be more seasonal than permanent as judged by a 15-year record.

The first serious difficulty developed in 1917 and 1918 when apparently the supply became infected with iron bearing and manganese bearing organisms. They grew luxuriantly and caused heavy deposits in the collecting reservoirs near the wells and in the mains. Their subsequent death and decay created bad tastes and odors in the supply. Treatment with copper sulfate, and later with chlorine, relieved conditions somewhat but was not an adequate solution of the problem. Mains became filled with deposits until many of them were nearly clogged. Service pipes became so filled as to stop the flow of water altogether.

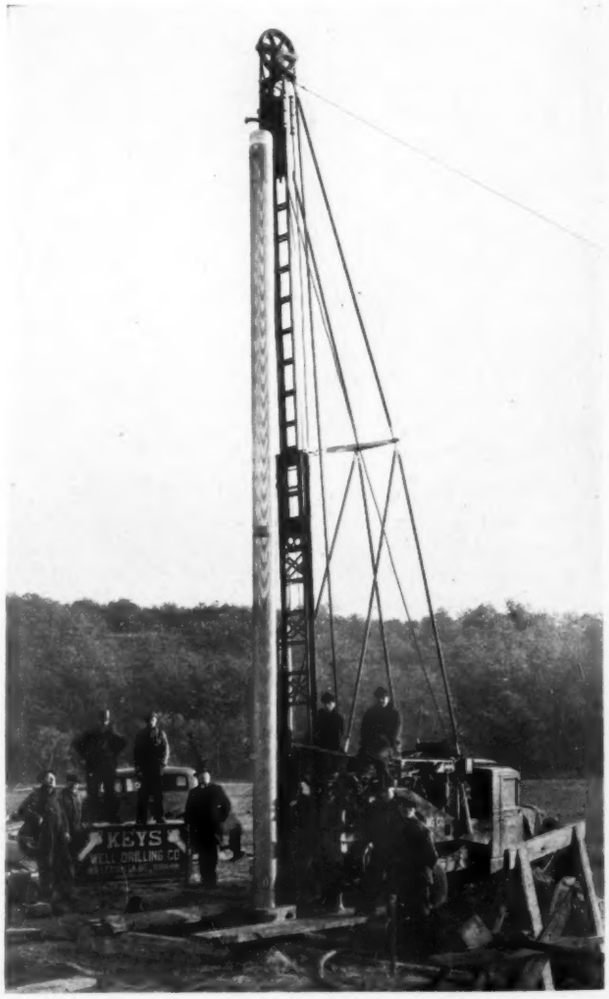
In 1929 the city authorities sought permanent relief and engaged engineers to consider the feasibility of treating the water supply for the removal of iron and manganese. The engineers thus employed found the removal of iron and manganese entirely practicable and prepared plans for a suitable treatment plant. However, there existed in the city a strong prejudice against treated or so-called "doctored" water. Stimulated by the knowledge that Chippewa Falls, a city of 10,000 population about 12 miles to the northward, obtains an adequate and satisfactory supply of ground water from shallow wells in the valley of Chippewa River, the opponents of treatment succeeded in defeating the project.

Following the defeat of the treatment project searches for a water supply free from iron and manganese were started by local committees assisted by the City Engineer and the State Geologist. These searches resulted in sinking test wells to the northward and to the southward of the city, but without conclusive results. Additional reference to these test wells will be made later. In 1932 the city administration engaged engineers with instructions to continue the search for an adequate supply of water which in its natural state would be free from iron and manganese. These studies were begun in June, 1932.

Geological Considerations

It was apparent from the beginning that a knowledge of local geology held the key to finding such a supply if it could be found. The chief geological features in the region of Eau Claire have resulted from glaciation. The entire country is covered with glacial deposits except for a number of ridges and peaks of sandstone which resisted the erosion of the ice. Prominent among the effects of glacial action are outwash deposits in the pre-glacial valley of the Chippewa River. These outwash deposits constitute a "valley train" which extends from a point north of Eau Claire down stream for many miles which follows generally, but not always, the course of the present river. This material is composed of clean relatively coarse sand and gravel and is of vast extent. The present river has cut through these deposits for approximately 70 to 100 ft. to form the immediate river valley. During this process of erosion the river developed many meanderings and much of the material in the glacial valley train has been reworked and interbedded with organic deposits resulting from growths in the backwaters and swamp areas existing from time to time during the river's post-glacial history. But all of the low terraces which border the river are not interbedded with organic deposits. Some have been merely cut or planed down to an elevation near the present river level. This difference in the character of the river bottom is significant as will be shown later.

The gravel outwash deposits, constituting the valley train, because of their coarseness and siliceous character, are the most important source of ground water supply in the area. The general glacial drift is also water-bearing, but the materials constituting this drift are mixed and the tributary drainage area at any particular point is uncertain and obscure. It is difficult, from obtainable information, to choose a locality where ade-



The 30-Ft. Length of Spirally Wound (Oil in Slots) Screen Used in Developing

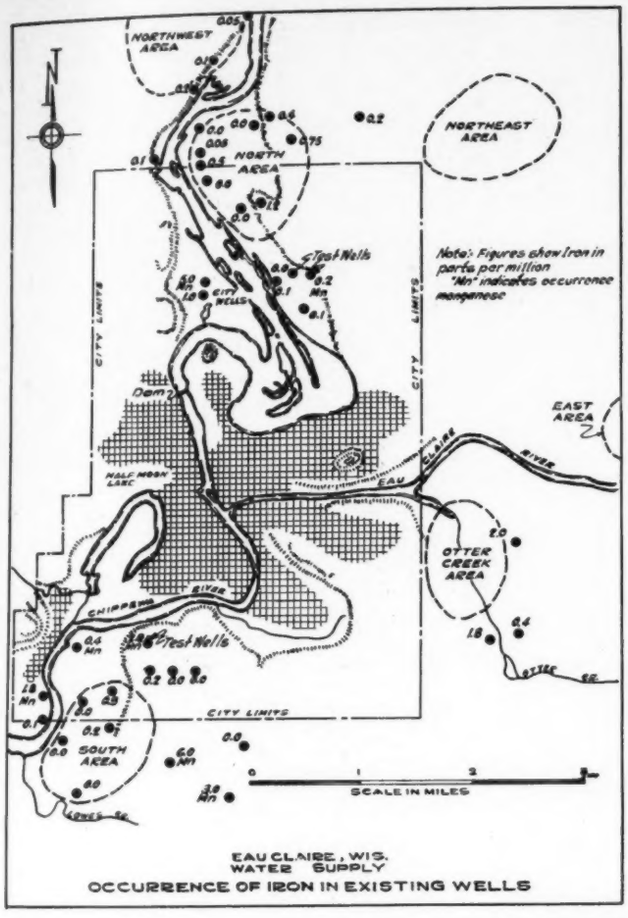


Fig. 1—Areas Showing Promise as Possible Well Fields—The North Area Being That Selected on the Basis of Results and Detailed Studies. Iron and Manganese Contest of Wells Indicated.

quate quantities of water may be obtained from the drift, whereas abundant quantities of water may be had almost anywhere in the valley train.

The local sandstone, which immediately overlies granite, is also water-bearing. In fact the outcrop of this sandstone constitutes the gathering area for large quantities of ground water which are obtained by means of wells in southern Wisconsin and northern Illinois. Locally, however, the sandstone is of relatively shallow depth, is fine grained and uncertain as to yield.

In view of these conditions principal attention was directed to the outwash deposits occupying the pre-glacial valley of the Chippewa River. While these deposits are clean (in fact an excellent quality of sand from them is exported from Eau Claire for use in rapid sand filters), nevertheless iron and manganese seem to be widely distributed.

Iron and manganese are dissolved by percolating ground water when such water contains little if any dissolved oxygen and contains carbon dioxide. This condition results when the water, falling as rain water, percolates through organic deposits. In the neighborhood of Eau Claire such organic deposits are extensive in the so-called re-worked river deposits. The undisturbed glacial material, though free from organic matter, may become the storage basin for iron and manganese bearing water.

In light of the foregoing, the best chance of finding an adequate supply of satisfactory water seemed to lie in discovering a location within the pre-glacial valley that was relatively remote from re-worked river deposits. This was not altogether easy as surface indications were not sufficient.

Selection of Most Favorable Well Locations

The area within reach of Eau Claire was inspected and all readily available data was obtained as to the quality of water derived from existing wells. With the information thus assembled it was feasible to select certain areas, indicated on Fig. 1, which gave promise of yielding water adequate in quantity by reason of their position along pre-glacial channels, and free from iron and manganese by reason of probable remoteness from re-worked river deposits. Analysis of samples from existing wells were limited in number and constituted evidence that was not altogether conclusive. Some former test wells were of special significance. Two were near what is designated as the "South Area" and two were located near the "North Area." The wells to the south were drilled on high ground and nearly in the middle of the old pre-glacial valley. Extensive pumping tests on these wells showed the presence of both iron and manganese. Of the two wells to the north, the one nearer the bluff showed the presence of iron in relatively small amounts. The well farther from the bluff showed small amounts of iron and some manganese. The locations of these and other wells subsequently investigated, are shown on Figure 1.

For purposes of comparison, estimates were made on a comparable basis of developments of ground water in each of the areas. These estimates indicated, as might have been expected from the locations of the areas, that the most economical developments could be made in the North Area, the South Area, or the Otter Creek Area. The North Area could be developed for less installation cost than would have been entailed for treatment works for the then existing supply. In fact, the estimated total annual cost for all of the ground water developments, assuming that treatment would not be necessary, proved less than for a development embodying treatment of the existing supply. In view of these indications, a more detailed study was made in the North, South and Otter Creek Areas. Analyses were made of water from all existing wells in and adjacent to these areas. Results are shown in the location sketch —Fig. 2.

Both the North Area and the South Area, but not the Otter Creek Area, gave promise of fulfilling requirements. As the cost of development of the North Area was definitely lower than of the South Area, further investigation was confined thereto.

Study of North Area

Analyses from the North Area revealed a curious characteristic, namely, that wells on the high bluff, about 70 ft. above the river level, all showed the pres-

The 30-In. Pipe and Pontoons. Tractor Is Pushing the Section Into the River from Assembly Point in Island Near East Bank. Note One of the Pump Houses Across River and Bluff Beyond.

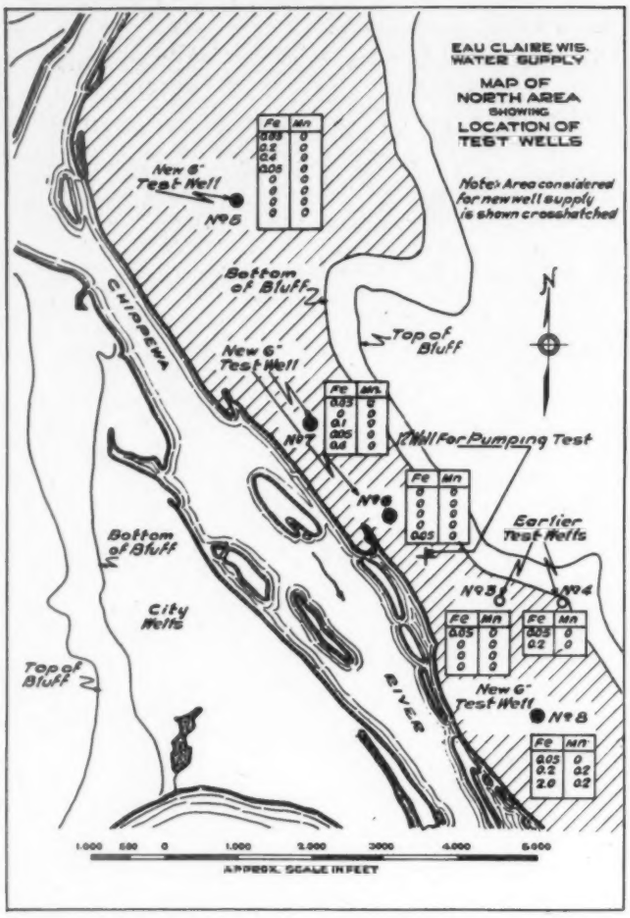


Fig. 2—Location of Test Wells in South End of North Area. Iron and Manganese Content of Wells Indicated in Boxes

ence of iron in more or less objectionable quantities. With the exception of one test well just south of the area, there was no evidence of manganese. Even at this well there is some question if manganese was found because its reported earlier presence is not borne out by available records of analyses. All of the wells on the low terrace (a few feet only above river level) yielded water containing either no iron or but a trace of it, and none of them contained manganese. A further study of the geology of this terrace gave evidence that aside from being river cut it is otherwise undisturbed glacial terrace and did not contain re-worked river deposits.

Inasmuch as ground water in the general locality of the North Area must percolate toward the river as a natural outlet, it seemed strange that wells relatively near the river yielded no iron, whereas, the more remote wells on the higher level did. It seemed necessary to assume that the water in moving toward the river dropped whatever iron was present in solution. This theory raised the question as to what caused the disappearance of the iron. The most logical explanation seemed to be that the ground water is sufficiently near the surface in the low cut terrace to be oxygenated from the atmosphere either directly or as a result of percolation of thoroughly oxygenated rain water. This theory is given strength due to the fact that the total depth of the stratum to bed rock is something less than 100 ft. and the material constituting the cut terrace is relatively coarse sand and gravel. The sand and gravel is clean and there is little or no top soil, thus favoring the penetration of atmospheric oxygen.

Acting on this theory a number of test wells were sunk as shown in Figure 2. The first of these wells is designated No. 5. This was located somewhat south of the geographical center of the wide portion of the cut terrace. If this well proved unfavorable, doubt would be cast on the advisability of further test wells in this locality. The fact that this well proved favorable, however, strengthened the belief that further exploration of the area was warranted.

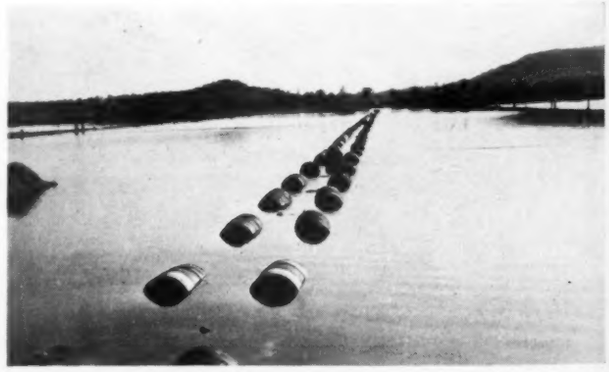
For reasons of economy it was desirable to utilize wells as far south as possible within the area so as to minimize the length of pipes necessary to connect a new supply with the existing distribution system. It was problematical, however, if successful wells could be located in the narrow part of the terrace where the bluff approaches to within six or seven hundred feet of the river, but test wells located in this area, namely, Nos. 6 and 7 shown on Figure 2, gave favorable indications, thus encouraging the belief that a permanent well might be placed in the same general locality.

Results of analyses of water from earlier test wells already referred to (Nos. 3 and 4 on Figure 2) indicated the probable southerly limit of water bearing deposits yielding water free of iron and manganese. However, to obtain more positive evidence, test well No. 8 was sunk. The level of the terrace was somewhat higher than at the other wells, and the depth to water was about 26 ft. Sandstone was encountered at 55 ft. Proximity to alluvial deposits was indicated. While the well was not pumped vigorously, analyses of samples revealed substantial amounts of iron and manganese. It was concluded therefrom that a permanent well should not be located south of Test Well No. 3.

Interesting support of the natural iron and manganese removal theory was afforded by the test wells. Gravel removed from these wells was coated with a blackish deposit. This deposit proved to be iron and manganese. It is of course possible that this iron and manganese is a fossil deposit and not related to the water now passing through the low cut terrace, but the more reasonable supposition is that it is evidence of the tendency of the water to become deferrized and demanganized by oxidation during its passage under the low cut terrace.

Extended Pumping Test

Wells Nos. 5, 6, 7, and 8 hitherto described were 6 inches in diameter. They were pumped but moderately; just enough to obtain clear samples. To test the yield and the possibility of iron and manganese encroaching within the low cut terrace it was decided to place a test well at the narrowest point of the terrace as shown on Figure 2 by the words "12-inch Test Well for Pumping Test." Accordingly this well was drilled and provided with a Johnson spirally wound slotted screen with 0.100-inch openings. The screen was 30 ft. long. The



The Flexible Jointed 30-In. Pipe Line and Pontoons After Floating Into Place Across River

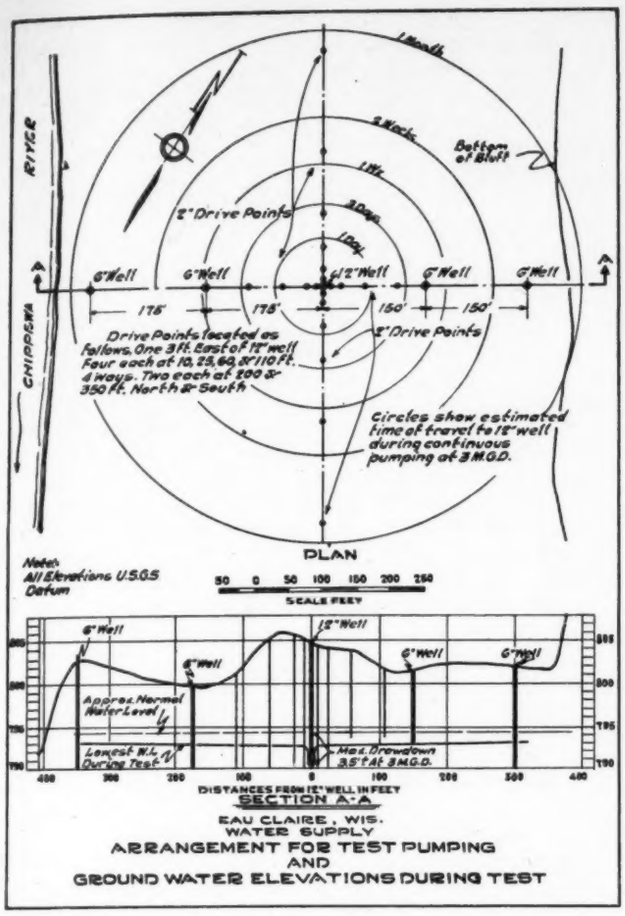


Fig. 3—Location of Major 12 in Test Well and 6 in Observation Wells and Driven Well Points Shown in Plan and Profile. Time of Water Travel Radially Inward at 3 M.G.D. Pumping Rate Is Indicated by Circles

total depth of the well was 89 ft. and the depth to water was 10 ft.

To observe encroachment of iron and manganese four observation wells 6 inches in diameter were sunk as shown in Fig. 3. These wells were placed in a row at right angles to the long dimension of the terrace. The two outermost were placed respectively near the river and the bluff and the two innermost were placed midway between the test well and the outer wells. (See Fig. 3.) If there was to be a tendency for iron and manganese to encroach on the centered 12 in. test well, it would be first observed at the outer wells, and then at the inner wells. This would permit some estimate of the rapidity of the encroachment. In addition to the 6-in. observation wells, numerous drive points were sunk, primarily for observing the draw-down of the ground water table, but also available for sampling. Figure 3 shows the arrangement of the central test well and the various observation wells in plan and also in profile.

The 12-in. test well was equipped with a motor driven deep well turbine type pump capable of delivering 3 M.G.D. The water was delivered into a flume which conveyed it to the Chippewa River. This flume was necessary to prevent the water from falling on the surrounding ground and returning to the ground water table, thus tending to obscure results.

Pumping was continued at the 3 M.G.D. rate 24 hours a day for 159 days. The water was always crystal clear and at no time did it contain iron or manganese. Samples obtained from the 6-in. observation wells also were substantially free from iron and contained no manganese. Of the total of 100 samples collected from the 6-in. observation wells, 3 showed iron in the amount of 0.3 p.p.m., one showed 0.25 p.p.m., 2 showed 0.2 p.p.m., 2 showed 0.1 p.p.m., 18 showed 0.05 p.p.m., and the remaining (74) were iron free. Of the total of 27 samples collected from the main 12-in. well, only one showed iron, and that in the amount of 0.05 p.p.m. only. The water from the 6-in. wells was pumped with a small gasoline driven pump through a suction hose lowered into the well casings and there is a possibility that some of the samples may have been contaminated with iron rust from the casing metal. That there was no tendency for iron to appear in substantial amounts in any of the 6-in. wells was surprising. The exact reason is not clear, but the time elements may offer an explanation. On Figure 3 the calculated time for ground water to move from various horizons to the test well is indicated by circles appropriately marked. These circles are based on the assumption of a uniform movement of ground water toward the test well from all directions. Such uniform movement doubtless does not occur, because of irregularity in the sand and gravel deposits and other factors. Nevertheless it appears that roughly three weeks to a month is required for a particle of water to move from either the river or the bluff base to the test well. As the outer observation wells showed no iron and manganese, it appears that oxygenation of the iron and manganese takes place comparatively quickly when ground water emerges into the low cut terrace either from beneath the river or from the bluff. Or it is possible that fine material near the bluff and near the river permit but a slow movement of ground water from these directions. In any event the results were more favorable than anticipated.

The yield of the test well was phenomenal. There are few wells in the country that can continuously yield 3 million gallons per day. Furthermore, the draw-down of the ground water table was slight; namely, 3.5 ft., as indicated on Figure 3. The water is not only free from iron and manganese, but is also soft. It is substantially a perfect water. The total hardness is from 35 to 40 p.p.m., whereas the total hardness of the water from existing wells is from 57 to 114 p.p.m., averaging about 80 parts. With such favorable indications it was deemed permissible to proceed with a permanent development.

New Supply Development

Present average daily water consumption is about 3.5 million gallons. Consumption for the maximum day is about 6.5 million gallons. In 1945 the estimated maximum daily consumption will be about 10 million gallons. An installation that will meet a maximum demand of 10 million gallons per 24 hours was deemed sufficient for the present. When additional wells are needed, they may be readily and quickly installed. Accordingly it was decided to construct four wells each with a rated capacity of 2.5 million gallons. Such ratings were regarded as conservative in the light of the results obtained from the test well.

All of the earlier 6-in. test wells indicated a marked similarity of deposits within the cut terrace. In each of the wells alternate layers of sand and gravel were encountered but generally speaking the finer material was within 30 or 40 ft. of the surface with the coarser material extending throughout the lower portion. No difficulty was anticipated in obtaining a well of good yield almost anywhere within the area of the cut terrace. Accordingly it was proposed to place four 16-in. wells spaced about 800 ft. apart along a line approximately midway between the base of the bluff and the river.

Plans and specifications were drawn on this basis. The general layout of wells and collecting mains is shown on Fig. 4. The water is delivered from pumps in the wells into an equalizing reservoir of 300,000 gallons capacity from which the water flows by gravity through a 30-in. cast-iron pipe to an existing 24-in. pipe from the old wells and thence to the existing pumping station in the city.

The contract for drilling and connecting the wells was so drawn as to permit some flexibility in the location of the wells. The location shown on the plans for well No. 3, the northerly of the two intermediate wells, proved unfavorable due to the presence of large quantities of fine sand. As nearly as could be judged, there was a fan shaped deposit of fine sand extending out from the bluff in this locality as indicated. Accordingly this well had to be placed somewhat farther south and nearer the bluff than originally planned. (See Fig. 4.) A number of prospective borings were made before a suitable location was found. Well No. 3 as finally built is a gravel packed well.

Only one of the permanent wells on test gave as large a yield as did the original 12-in. test well. However, the combined capacity of the four wells is slightly over 10 million gallons per day, with individual test yields of 2.7, 3.0, 2.5 and 2.0 million gallons per day respectively.

Because the wells penetrate a porous formation and a relatively shallow one, special provisions are necessary to protect the wells against surface pollution. To this end all drainage and sewage is carried in cast-iron pipe with leaded joints. Sewers are kept as far away from wells as possible. The city was advised to purchase 180 acres of land as a site for the wells. This area has been fenced in to prevent trespassing.

The area about the wells will be attractively planted. The architecture of the small well houses and the reservoir is of a rustic type utilizing native stone and harmonizes well with the park like character of the surroundings. Architect's drawing of one of the well houses and the reservoir are here illustrated. Additional illustrations show various interesting features of the project.

Construction Problems

The construction problems were simple. Perhaps the most difficult was a river crossing. Cast-iron pipe in 12-ft. lenghts provided with Victaulic joints was used for this portion of the supply main. The contractor, L. G. Arnold, joined the entire 1,400 ft. of pipe together on shore, and as successive lengths were connected, the pipe line was floated across the river with the aid of steel pontoons. The bottom of the river had been prepared with dredges supervised by a diver, and the entire 1,400 ft. of pipe was lowered into position. Successful placing in this manner was made possible by the flexibility of the joints. The entire operation of joining, floating and sinking the pipe was carried out within a period of 20 hours.

Improved quality of water was noticed by consumers within a day after the new supply was turned into the mains on October 16, 1934. On October 20th, "black" water appeared generally throughout the city but was of short duration. The occurrence suggested a simultaneous loosening of old deposits of iron and manganese from the mains and service pipes in numerous parts of the distribution system. On November 21st, a similar phenomenon was observed but was confined to the westerly part of the city. The explanation of these sporadic occurrences is not clear.

Reduction of deposits in mains and service pipes seems to be taking place continuously and without inconvenience to consumers. Whether the reduction is due to solution or imperceptible flaking off is not known. At any rate, mains and service pipes are gradually and obviously acquiring greater capacity.

Hot water from heaters and range boilers which was formerly badly discolored is now clear. The only feature of this new water supply which is not to the benefit of all is that plumbers are deprived of much employment for renewing clogged services and hot water piping.

By way of experiment, water from the 12-in. test well was permitted to flow slowly through a piece of old ¾-in. service pipe the opening in which had been reduced by incrustation to less than ⅛ in. in effective diameter. In 157 days the effective diameter had been increased to ½ in. This experience illustrates what is now taking place throughout the distribution system.

Acknowledgment is due to Dr. E. F. Bean, State Geologist, for much geological information and helpful guidance. The State Department of Health generously made numerous analyses of samples taken from many existing wells and also from test wells and during pumping tests. Mr. Edward Brown, Superintendent of Water Works, was of invaluable help by reason of his thorough knowledge of the existing water works. Mr. T. M. Niles was in direct charge of investigational work and the preparation of plans and specifications for the consulting engineers, Messrs. Greeley and Hansen. All of the work was done under the immediate supervision of Mr. A. R. Garnock, City Engineer, and co-author of this article.

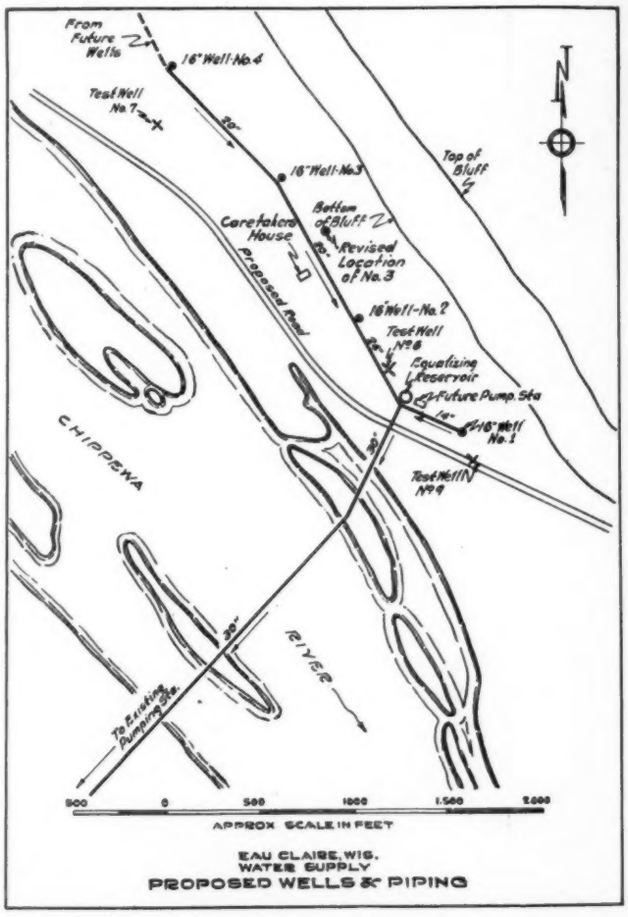


Fig. 4—Final Selection of Well Locations and Arrangement of Collecting Mains, Pumping Stations and Equalizing Reservoir in North Area. Combined Yield of the 4 Wells Proved to Be 10 M.G.D. For Protection the Surrounding Area of 800 Acres Is Fenced In

A. W. W. A. CONVENTION AT CINCINNATI AN OUTSTANDING ONE

A Digest of Proceedings Continued from the May Issue

WATER WORKS AND SEWERAGE for May contained the first installment of this report covering the most outstanding convention of the American Water Works Association in several years. The convention was held in Cincinnati, Ohio, May 6-10th with an attendance upwards of 1200. Recent gains in new members is indicative of the increasing recognition on the part of water works operators of the value of membership in the Association and the desirability of having available the many helpful papers which appear in the A. W. W. A. Journal.

From the first installment of this report; from this one and from a third to follow, a fair idea may be obtained as to the excellence of the convention as a whole, the content of many of the papers presented and the discussion which ensued.

Superintendent's Round Table*

(Management and Operation Division)
John B. Winder, Presiding.

Two full sessions were devoted to topics of especial interest to engineers and superintendents charged with maintenance, operation or management of water works systems. Topics of especial interest to those charged with treatment of waters were simultaneously being discussed before the Water Purification Division.*

John B. Winder
Dallas, Texas
Retiring Chairman
M & O Division

W. V. Weir, Superintendent
St. Louis County Water Co.
St. Louis, Missouri

"Prevention of Water Theft"—C. M. MCCORD, General Supt., Water Department, Memphis, Tenn.

Mr. McCord described and illustrated two novel schemes developed under his direction in Memphis for the purpose of reducing water stealing by turning-on cut-off services or by meter tampering. The first consisted of a special self-locking cut-off cock which comprised an ordinary cock with a special turning head on the plug and key to fit it. With wrench or other opening tools the cock could not be turned on unknown to the Water Department.

To prevent tampering with or damage to meters, a special locking meter-box lid and ingenious key were described and exhibited. The ingenious key opening the simplified center lock consisted of a tubular (ribbon) spiral, machined from a piece of pipe, which Mr. McCord explained was practically impossible to duplicate without the pattern.

H. L. MEITES, Supt. of Water Dept., Chicago, told of an organized water stealing racket in Chicago which had been uncovered by his department. Apparently the work of changing gears in large meters had been done by an organization who had employed men thoroughly familiar with methods of gear changes to create underregistration of 20 per cent or even more. For that service the customers had agreed to split the difference on the reduced bills in payment for the "meter adjusting service" rendered. Not satisfied with moderate profits, the racket became exposed when some billings had dropped to less than one-half of the normal average billings which brought about meter registration checkups and the uncovering of the racket.

"Meters and Possible Improvements"—In the open discussion of this topic it was thought that further attention should be given to the meter specifications of the Association in as much as no alterations had been made since 1920. It was pointed out that the overall length of various makes of larger-sized meters was not uniform and that there was nothing in the A. W. W. A. specification to cover that feature. C. M. STEWART, Superintendent of Water, Bedford, Pa., felt the existing specifications to be too liberal on compound meters at the change-over point and, with this, F. B. NELSON of New York City and others agreed. There was an expression that the accuracy tolerations in the A. W. W. A. specifications were unnecessarily liberal on smaller-sized meters.

H. W. NIEMEYER, of the Indianapolis Water Company, stated that he believed A. W. W. A. specifications covering meters were not rigid enough. He considered lack of delicacy was due to insufficient clearances of working parts and too great friction on the piston spindle through the stuffing box. Clearances of 0.006 to 0.007 of an inch between edge of disc plate and meter chamber walls had in his experience resulted in sustained accuracy of small meters.

W. V. WEIR, Superintendent, St. Louis County Water Company, University City, Mo., stressed the importance of breaking in repaired meters before testing incident to return to service or stock. By the "running in" operation meters of 95 per cent accuracy had been brought up to 100 per cent.

H. W. GRISWOLD, Deputy Chief Engineer and Manager, Hartford (Conn.), Metropolitan Water District, also felt that the length of large meters should be standardized. But, he suggested that drafting of new specifications should be temporarily delayed, pending the outcome of the considerable experimental work now under way on meters at various points.

"Handling Storage Yard Materials"—W. V. WEIR, Supt., St. Louis County Water Company, in discussing this topic referred to a valuable paper on the subject by J. S. Dunwoody, Supt. of Water, Erie, Pa., (See WATER WORKS AND SEWERAGE, November, 1933) and commented on the fact that the carrying of large inven-

*Elsewhere in this issue there appears a digest of papers presented before the Water Purification Division.—Ed.

tories in the yards entailed deterioration in some instances and also interest on investment and cost of storage facilities. (He did not point out, however, that a large reserve of materials purchased during recent years could now be considered as excellent investments, regardless of some possible deterioration. For instance—Copper tubing or service pipe is not subject to deterioration of consequence and a water utility enabled to stock up with such material purchased during 1931-1933 are to be envied.)

Mr. Weir considered it best practice to avoid handling of materials through a stock-yard, as far as practicable, and advocated delivery from freight yards or car direct

C. M. McCord, General Supt. Water Department Memphis, Tenn.

Thomas L. Amiss, Supt. Water & Sewerage Shreveport, La.

to the job. For heavy equipment and pipe unloading he described an efficient I-beam and electric hoist arrangement for which a service charge of $2.00 per month was all that it cost the water company.

"Hydrant Survey and Markings"—THOMAS L. AMISS, Superintendent, Water Works and Sewerage, Shreveport, La.

Mr. Amiss described how a survey of hydrant capacities had been conducted in Shreveport and referred to the method of testing of hydrant and main capacities developed and described by P. S. Wilson (See WATER WORKS AND SEWERAGE for April, 1935—"Methods for Making Hydrant Discharge Measurements"). From the survey, hydrant markings to indicate capacities had been possible and the painting scheme followed had been practically that recommended by the Committee on Uniform Marking of Fire Hydrants of the American and New England Water Works Associations. For the body, chrome yellow paint had been used. Various colors for the hydrant tops indicated the following capacities from the hose nozzles, with residual pressures at full delivery of one-half the original at the hydrant, the minimum residual pressure acceptable being 20 pounds during the specified deliveries.

Class	Top and Trimmings	Yield
(A)	Green	1000 g.p.m. or more
(B)	Orange	750 to 1000 g.p.m.
(C)	Red	500 g.p.m. or under

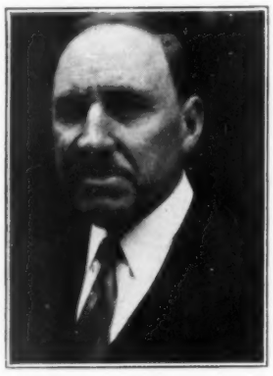
He said that 312 hydrants had been so tested in three sections of the city by operating grouped hydrants simultaneously so as to have 16 streams (4000 g.p.m.) flowing in some instances and 8, 6 or 4 in others, depending upon the likelihood of the number of hydrants to be used at a fire in the vicinity of the test.

"Ledger vs. Stub Billing"—T. G. BANKS, Supt., Water Works and Sewerage, Oklahoma City, Oklahoma.

Mr. Banks argued in favor of the more complicated but more efficient machine (stub) billing system for water works serving 10,000 or more consumers but believed the ledger system more practical and economical for the smaller water works. The chief advantages of the machine system was its accuracy and the quickness with which accounts could be balanced and bills distributed—i. e., 2 days compared with 8 to 10 days with ledger systems. Ease and quickness of locating accounts; improved handling of delinquent accounts, and better collections were other advantages. For billing they had installed a Burroughs Model No. 2 machine and for addressing an Address-o-graph machine was being used, with the result that the work of getting out bills had been more evenly distributed over the month.

H. F. BLOMQUIST, Supt., Water Works, Cedar Rapids, Ia., did not concur in the opinion of Mr. Banks, that accounts could be more speedily located with the stub billing system.

The matter of legality of showing the delinquent portion of water bills on post-card notices and bills was a question raised. T. A. LEISEN (Omaha, Neb.), said that it had been allowed in Omaha without objection by the postoffice authorities. There had been, however, only 0.2 per cent delinquent accounts in Omaha. G. W. KNIGHT of Natrona, Pa., said that listing on post-card as "Other Charges" had been allowed his company by the postal authorities, whereas any term indicating delinquency was not allowed. JAS. E. GIBSON (Charleston, S. C.) reported that postal authorities required them to mail cards showing amounts of delinquency in envelopes requiring local postage of 2 cents. Meters had been read only every 3 months in Charleston, making it possible to distribute meter reading and billing of more than 10,000 accounts over the 90-day period at the rate of 300 or more per month. To satisfy an apparent demand for monthly meter readings instead of the quarterly readings the customer has been offered monthly readings as optional. For this, a service charge for the



H. F. Bloomquist Superintendent, Water Works Cedar Rapids, Iowa

R. B. Simms, Supt. Water Works & Sewerage Spartanburg, S. Car.

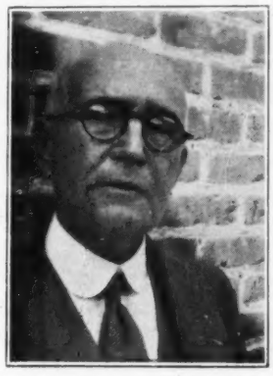
two additional readings and billings is required if the bill is below the minimum of $1.00 per month. So far the plan has not been in demand, only 0.3 per cent of the customers having requested the change of monthly readings.

"Hand Billing" also came in for discussion but there was no support given it by those who had already tried this scheme. John Chambers reported that hand-billing is now under test in a modified form at Louisville, Ky.

"Service Lines and Pipe Locators"—J. WALTER ACKERMAN, Assistant General Manager, Consolidated Water Company, Utica, N. Y., told of a method of installing service lines of copper tubing which involved

the use of old pipe cut into 4-ft. sections and threaded at each end. From a pit these short lengths were driven through the earth with an air hammer and were connected by couplings as they were driven through. The old pipe and copper tubing was connected at one end and a pipe pusher, used as a pipe puller, at the other end, was used to draw the old pipe out in sections. Behind it the copper service tubing followed, thus avoiding the cost and damage to pavement or lawn incident to cutting a trench. (For replacing old services with copper tubing the operation is even simpler. The old pipe is

George J. Rohan
Supt. Water Works
Waco, Texas



Major John B. Hawley
Consulting Engineer
Fort Worth, Texas

already in place and the tubing follows through during the pipe pulling operation. Sections of the old service pipe are sawed off at the puller pit as frequently as required. An article describing this scheme may be found in the 1935 edition of *Water Works and Sewerage Reference and Data Book*.—Ed.)

"Lead vs. Compound Joints"—Leading in the discussion of this topic JAS. G. GIBSON (Charleston, S. C.) called attention to the fears of rigid compound joints and possibility of cast iron pipe breakage due to beam action. He considered the improved De Lavaud centrifugal cast pipe much superior to the ordinary De Lavaud pipe and thought it equal to or better than the old pit cast pipe. He did prefer 12-foot-length pipes because of greater ease of handling, but felt it otherwise no safer than the 18-foot pipes. W. W. BRUSH's experience had led him to believe that 18-foot lengths were stronger than those of 12 feet and T. J. SKINKER (St. Louis, Mo.) reported little or no difficulties with 16- or 18-foot Class 200 De Lavaud pipes laid with compound joints. P. R. MCNUTT (Toledo) reported considerable use of 18-foot pipes, 4,000 ft. being recently installed without breakage.

"Battery Meter Installations"—C. M. MCCORD, General Superintendent Water Department, Memphis, Tenn., was asked to give his experiences with installations of batteries of small meters as against the use of larger meters. He said that, contemplating such installations, careful tests had been made to compare three tandem connected 2-inch disc meters between two manifolds, with a 4-in. compound type and a 4-in. turbine type meter all connected in series. They had found 25 per cent more water registered by the 3 meter battery. The greater registration appeared to be due to the inaccuracy of the compound meter at the change-over point. Low flows were more efficiently measured by the battery if some resistance was placed in front of two of the units to cause all of the flow to pass through but one of the three meters. As the flow increased, two and finally all three would be registering. Greater head loss was felt through the battery than the compound meter and the least loss was through the turbine meter. Where pressure loss was unimportant the battery meter installation had much in its favor. To avoid the use of many fittings and waste of time in making up manifolds, special twin manifold castings had been designed for the inlet and outlet sides of battery meter installations.

Hydrants Owned and Maintained by Fire Departments—In a discussion of hydrant maintenance an interesting and unusual circumstance was disclosed by Mr. Skinker, who stated that in at least two cities, (Cincinnati and Detroit) fire hydrants did not come under the Water Departments. The Fire Department in each of these cities purchase, install, maintain and test all fire hydrants.

"Pipe Locators"—THOS. L. AMISS, Supt. Water and Sewage, Shreveport, La., reviewed his experiences in locating water mains with a new locator known as the "Terrometer." He explained the operation of this unique pipe locating device which he said was truthfully a wireless mechanism, easy to use and very accurate. The principle used in the "Terrometer" was that used in locating deposits of iron ores many feet beneath the surface.. Mr. Amiss having previously described the "Terrometer," and his experiences with it, in the December, 1934, issue of WATER WORKS AND SEWERAGE, read from the article in part.*

In an earlier discussion it was the consensus of opinion that some form of dependable main locating device had come to be considered an almost indispensable item of water works equipment.

"Water Department Organization for Emergencies"—W. S. PATTON, Manager, Water Department, Ashland, Ky., told of the system employed at Ashland wherein at least one foreman can be reached on the 'phone at all hours. That man was considered on continuous duty regardless of where he might be, and receives extra pay for it. Every two weeks an alternate foreman becomes the emergency man for the ensuing two weeks and these men are allowed to substitute for one another when occasion justifies it.

In emergency planning at Syracuse, N. Y., three repair crews are maintained and each serves on an eight-hour shift. Emergency trucks are equipped with short wave police radio receiving sets to receive orders or calls in an emergency at any hour.

W. W. BRUSH stated that the system in the New York City Department of Water Supply was similar to that at Ashland. An engineer is on duty 24 hours per day whether at home or at headquarters. Three emergency gangs are on duty continuously on 8-hour shifts but it was his opinion that on all large systems a skilled and experienced engineer should be available at headquarters at all hours to direct emergency gang operations.

"The Superintendent and the Public"—R. B. SIMMS, Superintendent of Water and Sewage, Spartanburg, S. C., commented on matters which he considered worthy of recognition by water works managers who wished to get built up genuine good-will toward, and an interest in, the most important public utility. Among the highlights of his discussion was the fact that water supply is usually the largest single industry in the city, whereas the responsible head (superintendent or manager) receives less than one-half the salary paid by industrial plants of similar size for comparable services and responsibility. While the average citizen was impressed by the uniformed services (police and fire) he might be surprised to learn that the National Board of

*Note: To anyone interested in Mr. Amiss' article setting forth his experiences with the novel "Terrometer" a copy of the December, 1934, issue of WATER WORKS AND SEWERAGE will be supplied as long as copies may be available.—Ed.

Fire Underwriters placed more weight upon Water Department facilities, its equipment and management, than it did on the Fire Department. Perhaps the business men of the city would be impressed with the fact that they were paying but 8 cents per ton for a material which turned out as much as ice cost them, at $12.00 per ton. These and many other interesting aspects of the water supply business could be used in publicity efforts to make citizens water-works conscious.

Mr. Simms stressed the growing importance of doing a real selling job on visitors to the properties of the

Three Aces

Marsden Smith, Filtration Engr., Richmond, Va.; A. M. Brencke, City Engineer and Supt. Water, Denison, Texas; W. U. Gallaher, Superintendent Water Works, Appleton, Wis.

Water Department. He spoke of the benefits from beautification of buildings and grounds and the very marked effect procurable through the establishment and maintenance of well-operated recreational facilities on water-works properties. His own personal experience in the latter had proved it a decided success in Spartanburg. Selling the Water Department to the public was a too much neglected feature of water-works management.

"Experiences with Commission Management of Water Works"—GEORGE J. ROHAN, Supt. Water Works, Waco, Tex., was called upon to relate the experiences of water works operation at Waco under the Commission Form of Management. He had nothing but good to say about this scheme of management which has worked so satisfactorily at Waco, Tex., since 1904. The Water Board, he explained, was an elected group of 5 men of high community standing, each serving two-year terms without compensation. The Superintendent and Secretary of the Water Department are selected by the Board to actually operate the works and were given full authority as to employment, purchases, etc. The Board defined policies, fixed rates and decided on all major projects. By charter, political interferences are barred from the Water Department very effectively and completely, and there has been no friction between the Water Board and other city departments or commissions who by law, incidentally, must pay for all water used. By law, also, the profits from operations of the Water Department are limited; but, even so, $1,500,000 for improvements have come out of revenues during the existence of the Commission Management. With it all, a rate reduction and special summer rates for lawn sprinkling have been recently made in the face of the $2,000,000 bond issue of 1928 for improvements which included construction of Lake Waco and pipe line which now provides an abundant and good quality supply at a reasonable charge. The Water Works of Waco was now a $4,000,000 valued utility, which offered secure positions to happy and efficient employees. It was truly a public service enterprise and operated on a business-like basis under the control of five leading Waco citizens, serving for the public good without pay. As a responsible head he could highly endorse the system without reservations.

Symposium on Reconditioning Water Mains

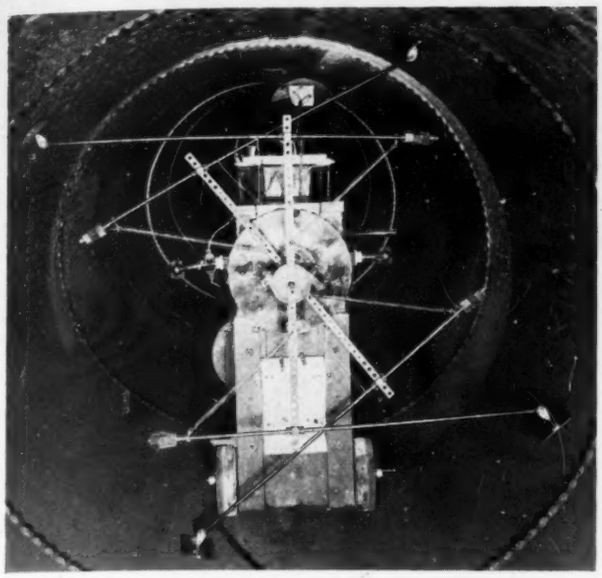
A symposium consisting of three papers dealt with a topic of considerable importance in the economics of water works practice, and one receiving increasing attention, viz: The developments in reconditioning interiors of pipes and their preservation against further tuberculation by the application of protective coatings of bituminous enamels or cement linings applied to mains, which have already suffered depreciation in carrying capacities and increasing pressure losses due to internal wall roughness.

"Reconditioning Water Supply Mains with Bituminous Enamels"—By LINDEN STUART, Pres., Wailes Dove-Hermiston Corporation, New York City. (Presented by George E. Boyd, District Manager of the Company.)

Mr. Stuart's paper called attention of the well-established fact that ordinary hot dip tar coatings have not proved sufficiently dense or thick to protect iron pipes against attack by aggressive waters and that the resulting tuberculation had been responsible for a heavy loss in capacities of water mains. Also, that this had been considerably more pronounced and more costly in numerous cases than anticipated by designing engineers. Coal-tar base linings had proved superior to asphalt after 18 years of actual service, the water absorption of the enamel being only 0.25 per cent at the end of that period of continuous service. He warned against evaluation of coatings based on laboratory analysis or demonstrations, because time and actual service had proved the only dependable check on permanency and sustained resistance of coatings suffering increasing age. Based on extended observations, it was apparent that coatings less than 1/16th inch in thickness were sufficiently protective.

New pipes were easily and densely lined at the pipe foundries by centrifugal methods. Now, the problem of lining mains in place was being perfected and had been prosecuted with success where properly done. Such had been the case in Jersey City, in Newark and in New York City, where the method had been largely developed and first put to use. Experience had indicated it practicable to apply hot bituminous enamel linings to mains in place provided the pipe is 30-inch diameter and upwards. The preparation of the main involved an ordinary water main cleaning job first. Thereafter, hand scraping and wire brushing of the *dried* interior had proved the most practical and economical method of preparation. Much depended upon effective ventilation during cleaning and coating which involved main openings made at 1,000 ft. intervals and the use of effectively located blowers. For riveted pipe, special rivet head cleaning equipment had to be used. After cleaning and drying, a priming coat was used and then hot enamel was applied by hand brushing to 1/16-inch thickness. Newark had lined 40 and 42-inch pipe and Jersey City had been applying hot bituminous linings for two years —lately as a work-relief project.

Mr. Stuart reported that the expense of preparation of and reconditioning the larger mains with rented equipment had mounted to only 20 to 25 per cent of the cost of installing new mains, and the important aspect was that, once done properly could be considered permanent. Where letting reconditioning jobs to contractors, he emphasized the importance of selecting experienced firms and also the insistence by engineers of a 2 to 5-year maintenance bond and rigid adherence to specifications covering procedure and materials. Mains now 8 to 18 years in service, with bituminous enamel linings properly applied, had been examined and found free of tuberculation by the aggressive Catskill water supply of New



Cement Lining Machine—Operating in 72-Inch Riveted Steel Conduit Installed in Jersey City, 1902.

York City. This record would stand for itself regardless of improvements in materials and methods of application during the interim.

"Cement Lining of Large Diameter Mains in Place by Centrifugal Machine"—By E. T. KILLAM, Alexander Potter Engineers, New York City.

Mr. Killam's introductory statement disclosed losses in carrying capacities of mains after 30 years of service amounting to between 30 and 50 per cent on large sizes and 30 to 85 per cent on smaller sizes, which was a condition deserving of considerable thought and more attention. To recover such depreciation, cleaning and lining of existing mains in the field held promise and shop lining of new pipe could be justified as an added expense in the majority of cases.

For pipes of small diameter the Tate process of cement lining, now under development in England, seemed to have practical merit. For sizes of 30 inch and up the hand application of hot enamel was available and with sizes of 48 inch and larger, which permitted use of centrifugal machine application, the use of cement mortar held probably the greatest promise from the standpoint of cost and practicability.

In cement mortar lining, Mr. Killam pointed out that the removal of tubercles, followed by washing down without drying, was the only preparation required ahead of the centrifugal application and machine trowelling of the mortar. He then described the machine and methods recently perfected for such lining operations. With the centrifugal machine the use of internal reinforcing and thick linings was practicable where the pipe walls had become dangerously weakened by corrosion. He told of linings of ¼ inch normal thickness of mortar applied to 72 inch diameter steel pipe which had not shown more than hair cracking after a loading on the pipe which created 13 inches of deflection. The mortar consisted of 1 cement to 2 of fine sand which, after application and the steam curing operation, had a density practically that of centrifugally factory spun linings in new pipes. Water absorption by the removed lining had amounted to between 6.5 and 8.5 per cent. A moving picture was used to illustrate the ingenious three unit equipment in service which is used in transporting and applying, without waste, the lining of cement mortar —(see illustration). Rapid curing by subsequent steaming out of the main was also illustrated.

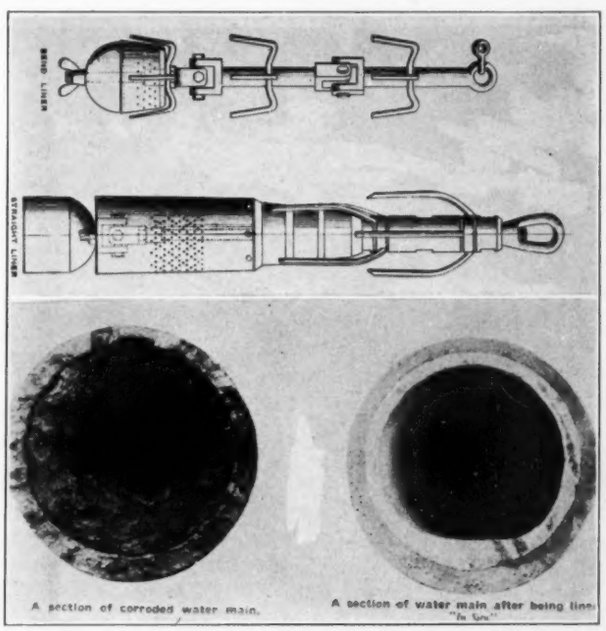
"Application of Cement Mortar Linings to Existing Mains in England"—By THOMAS H. WIGGIN, Consulting Engineer, New York City.

Mr. Wiggin described and illustrated, by lantern slides, the Tate process of cement lining small diameter mains which he had only recently observed in operation in Manchester, England. This process had been successfully used on mains up to 5 inches in diameter in the ground and on pipes up to 9 inches in the yard. The preparation consisted of a pipe cleaning job to remove tuberculation followed by running through a "prover." Then the charge of stiff-mortar (1 cement to 2 sand hand mixed for 1 hour) was forced into the pipe through a tee. Then the mandrel was inserted and pulled through slowly by a cable running through a 200 to 400 ft. section of main to a manually operated windlass. Mr. Wiggin said that the lining of bends and reverse bends had been successfully accomplished by the flexing mandrel and that 200 to 400 ft. sections were cleaned and lined completely in a 24 hour period.

Conducting flow tests on newly ⅜ inch thick lined sections, coefficients for 3, 4 and 5 inch mains of C = 148 to 157 were obtained when figuring on actual effective diameters, or C = 63 to 97 when computed on the original size of the pipes. From calculations based on applying a less heavy lining (⅛ to 3/16th inch), the coefficient would have been C = 108 instead of the C = 88 as observed for 4 inch pipe with the ⅜ inch lining.

Freshly lined sections of mains with Portland cement mortars produced a caustic water of pH 11 or slightly higher for a time, but this gradually dropped to pH 9.5 after 14 days' service. Ciment Fondu mortars had produced an initial causticity of only pH 9.0 which had dropped to pH 7.5 on the second day.

The total cost of the lining, when averaged for 3 to 5 inch sizes, amounted to 72 cents per linear foot with but little variation on the three sizes. Of this, the Tate Company received 29 cents per foot for their services and made a fair profit. The materials cost was negligible. In American practice Mr. Wiggin had esti-



Equipment and Results—Tate Process of Pipe Lining. Above: Mandrels Used in Expanding the Batch of Cement Mortar Injected into the Pipe. The Upper Mandrel Is Used Only for Lining Bends and Offsets, Doing a Good Job of It. Below: Before and After Cleaning and Lining a Section Observed by Mr. Wiggin in Manchester, England.

F. N. Speller
Director of Research
National Tube Company

mated the allowance for lining mains 4 to 12 inch diameter as being 30 to 35 cents per foot in small communities and 75 or 80 cents for larger cities with more pavement cutting and street openings to contend with. One special item of trouble and expense was that occasioned by the necessity of shutting off services during cleaning and lining. The Manchester Corporation has been so well pleased with results, however, that about 25 miles of main lining by the Tate Company was being contemplated for 1935.

F. N. SPELLER, Director of Research, National Tube Company, Pittsburgh, Pa., in discussion, commented on the progress in corrective chemical treatment of waters to subdue corrosive action. However, the softer waters would require rather high amounts of alkali in order to raise the pH to 9.5 if corrosion was to be corrected. Cement lining were especially interesting in that even where the lining had lost its cement content and become chalky after years of service, it continued to protect against corrosion. In one case a lining after 50 years of service (⅜ in. thick) was markedly chalky but no corrosion was in evidence.

JAS. G. GIBSON (Charleston, S. C.) who had pioneered in cement lining of pipes felt that the Tate scheme held great promise in rehabilitation of existing small mains. Shutting off the house services was a troublesome job and if avoidable the scheme would be much improved. He was happy to see that the truth about the value of prolonging the life of mains with adequate linings was taking a more rapid hold in this country.

Corrosion of Service Pipes and Its Correction (Joint Session of M. & O. and W. P. Divisions) (A. E. Berry, Presiding)

Before the 1934 Convention of the Association, Dr. F. E. Hale and W. W. Brush reported on observations in connection with studies made to determine the resistance of service pipes of various materials to the corrosive Catskill water supply of New York City. (See "Pipe Corrosion Experiments, Catskill Supply of New York City," Jour. A.W.W.A., Oct., 1934.) More information was in the process of being procured at the time; and, data assembled subsequent to the 1935 presentation was revealed in the following papers.

"Observations on the Corrosion of Wrought Iron and Steel Pipe in Buildings"—By W. W. BRUSH, Editor, Water Works Engineering, New York City.

Mr. Brush reported on surveys made of conditions of piping in 43 buildings in New York City, the findings having borne out the conclusions reached in the laboratory scale studies under Dr. Hale's supervision. Wrought iron pipes had apparently suffered deterioration due to corrosive clogging practically as pronouncedly and as rapidly as had steel pipes of the same size. The period of useful service had been fixed by the rate of clogging up, due to corrosion, rather than pitting through of the walls. The life of W. I. pipes under 1¼ inch was found to be between 10 and 15 years; from 1¼ to 2 in. about 30 years. Steel pipe of 1¼ in. and less had clogged in just about the same time and 2½ in. had failed due to clogging after 28 years. Red-brass pipe in service 20 years or longer had given no trouble and also in a few buildings W. I. pipe had given little or no trouble after 20 years. Yellow (ordinary) brass had failed very rapidly, with leaks developing at the threads after only 2 years of service. It had to be concluded that neither W. I. or steel pipe were economical to install where corrosive water was involved in sizes under 2 in. and that in such cases the use of red-brass or copper was justified at the added cost over wrought iron or ordinary brass pipe. With the corrosive Catskill water there was little to be gained by use of W. I. in place of steel. A large scale experiment with soda ash conditioning had not yielded results compatible with the cost of treatment to reduce corrosion.

"The Effect of Excess Lime Treatment Upon Corrosive Properties of the Soft Catskill Supply"—DR. FRANK E. HALE, Director of Laboratories, Dept. Water Supply, New York City.

Dr. Hale in bringing up to date the studies made on treatment of Catskill water to correct its corrosive tendencies, reported on several series of small scale (2¼ g.p. hr.) carefully controlled tests, involving pipe of the various commonly used materials. In the studies reported the addition of varying amounts of lime had been resorted to. Soda ash or lime sufficient to raise the pH of the raw water from 7.2 to 8.1 (pink to phenolpthalein) was of little or no effect. At a pH of 10.1 to 10.5 corrosion was checked. Since the pH change above 9.5 was not marked with increased lime application it proved necessary to use hydrate alkalinity by titration as the index. With that index it was found that 10 p.p.m. hydrate alkalinity was necessary to overcome cold water corrosion of iron piping and prevent corrosion and subsequent clogging. There was no deposit of a calcium carbonate film such as is had when liming harder waters. The dosage of 200 lbs. per m.g. of hydrated lime, required to produce 10 p.p.m. hydrate excess, was not sufficient to impart a limey taste, but it had raised the hardness of the water to about 50 parts. Higher quantities of lime (40 parts and better hydrate) produced deposition in hot water pipes and when fed through old corroded, partially clogged, pipes (cold) resulted in an unloading of the iron oxide in a colloidized condition. While the protective effects from lime, to maintain 10 p.p.m. excess $Ca(OH)_2$ alkalinity (35 p.p.m. total alk. and 50 hardness), had been slow developing, it was in the end the most effective treatment of the soft Catskill water for the several pipe materials involved, including brass and copper. Whether such a treatment, involving 60 tons of hydrated lime per day for 600 m.g.d. consumption, which would raise the hardness to 50 p.p.m. would be wise, remained a question. For correcting an industrial supply, to raise its alkalinity but preclude deposition of calcium carbonate, the raw water might be partially acidified aerated to expel carbon dioxide and then treated with excess lime or other alkali.

F. N. SPELLER, Director of Research, National Tube Company, Pittsburgh, Pa., remarked that such exact studies as that conducted by the New York authorities on liming very soft waters had not heretofore been made. The contribution was of value in that it indicated a film protection, created by iron hydrate rather than a calcium carbonate film, was to be had. In the case of cement lined pipes such a condition would be found at the metal-cement surface contact and the carrying capacity of such pipes had not changed during 10 years of service.

Mr. Speller said that his experience was about that

reported by Brush and Hale—that ungalvanized wrought iron and steel pipes became pitted and clogged with approximately equal rapidity and intensity. He said that the newer A.S.T.M specifications for galvanized pipes called for a zinc coating of 3 oz. per sq. ft. and such would materially extend the life of both W. I. and steel pipes. Revealing the effectiveness of 200 lbs. per m.g. of hydrated lime added to the Catskill water had a decided significance in future trends in corrosion control. In New York City sodium silicate forced into the water entering certain buildings, to raise the pH to 8.1, had been decidedly helpful but even more so in other cities with harder water. The equipment required was simple and chemical cost had been but $3.00 per million gallons in New York City; elsewhere less.

Mr. Speller, commenting on the selection of pipe materials, said that the quality of water must govern in the end. Cement lined pipe was but little more expensive than galvanized and had a better record in corrosion resistance. For corrosive conditions it would probably develop that a combination of cement lined steel with copper pipe would prove the most practical selection.

GEORGE D. NORCOM, remarked that Dr. Hale's findings would reveal to many operators the reason for their disappointment when attempting corrosion control with moderate dosages of lime. For instance, to raise the pH of the water to that which had been effective on less soft supplies—(pH of 7.6 to 8.1) had been insufficient and the New York results had shown the need of considering abnormally high pH values on some soft waters.

L. H. ENSLOW made the statement that others had learned the need for high pH values in checking corrosion by very soft waters—such had been the practice developed, for instance, at Providence, R. I., and at points in the South, but not quite to the degree reported by Dr. Hale.

He questioned the wisdom of such treatment with lime alone to create a jump in the natural hardness of 15 up to 50 parts per million, and it was his impression that the 10 p.p.m. hydrate alkalinity could be more satisfactorily gotten by use of a combination of a caustic soda and reduced lime with consequent less marked hardness increase.

Another approach to the problem had occurred to him as a possible solution to the hardness increase problem. With harder waters a lower lime dosage sufficed and no caustic alkalinity was required. Therefore, it sounded feasible to add a cheap hardening salt such as calcium sulphate or chloride to the water to produce 35 to 45 parts of hardness expressed as calcium carbonate. Immediately following soda ash (carbonate of soda) added would produce colloidal calcium carbonate, as in water softening. The result would be a plating out of the carbonate film on the mains and pipes with a consequent hardness reduction and ultimate hardness of 15 or 20 p.p.m. within the pipe system. Thereby, a soft water of a depositing character would be the result, instead of a caustic and hardened product which Dr. Hale had doubted the wisdom of producing. The use of caustic soda with lime in economical combination would likely prove the least expensive of the two methods, if not, in addition, the most practicable.

(This "digest" of papers read before the Cincinnati Convention of the A.W.W.A. will be concluded in our next issue.—Editor.)

Have You Voted?

(Last Call for Plant Picture Contest)

If you haven't sent in your selection from the group of "Representative American Water Works Plants," which were pictured in our April issue, please assist us by casting your vote for 1st, 2nd and 3rd choice, based on architectural attractiveness.

See the selections and opinions of three editors of leading architectural magazines on page 194 of our May issue under the heading—"Our Dilemma"—and help us in a decision based on our readers' opinions.

Vote Now. A postal card will serve. Mail it to 155 East 44th St., New York City—L. H. Enslow, Editor.

New Laboratory Manual (A Review)

"A Laboratory Manual for the Chemical Analysis of Water and Sewage," by E. F. ELDRIDGE and F. R. THEROUX, of Michigan State College, East Lansing, Mich., has been recently received.

This useful manual contains four parts. The first section is devoted to detailed, step by step directions for the analytical procedures used in water, sewage and water pollution analysis. The second section gives detailed instruction for the preparation of all standard solutions and reagents used in making these determinations. The third section, of considerable value to most Sanitarians, contains a brief theoretical discussion of the fundamentals of chemistry necessary for a correct interpretation of analytical results. The fourth (Appendix) includes suggestions for sampling, laboratory technique and a number of tables containing data of use to the laboratory worker.

With this book, the water or sewage plant operator, consulting engineer, student in sanitary engineering, and those whose training in chemistry is limited, will have a ready reference to simple, concise and detailed laboratory directions and an opportunity to obtain some further knowledge of the chemistry involved in these determinations. In many respects this new book is a valuable companion to the Standard Methods of Analysis of the A. W. W. A. and A. P. H. A. It tells the novice more.

Publishers, Edwards Brothers, Inc., Ann Arbor, Mich. Price (fabricoid bound), $2.00.

Introducing "Colonel" Northrop

The Colonel

The *Cincinnati Enquirer* of May 29th carried the following news item captioned "New Kentucky Colonel," which announced that Guy C. Northrop, President of the American Water Works Manufacturers' Association, had received a commission as Colonel on the staff of Governor Laffoon of "Ole Kaintucky." This honor was bestowed upon Mr. Northrop at a luncheon attended by a group of business and professional men in Cincinnati. Acting for Governor Laffoon, Colonel Earl A. Munyan, also a member of the A. W. W. A., presented the commission.

A STUDY OF FILTERING MATERIALS FOR RAPID SAND FILTERS

Part 5: The Sand-Gravel Interface*

By JOHN R. BAYLIS[1]

Associate Editor

IN the first installment of Part 5* it was shown how the gravel in filter beds becomes disturbed by jet action at the sand-gravel interface. This is not the cause of all trouble which may develop. Sand boils, clogged areas, and uneven distribution of the wash water produce a great deal of the unevenness of the gravel layers and makes necessary the reconstruction of more filter beds than any single cause.

Sand Boils at Beginning of Wash.—When the wash water is turned on a filter the sand will first rise one or two inches, then the water breaks through at various points over the bed. Frequently the points where it breaks through are close together and the sand boils are not very large and do not disturb the bed very much. Often, however, very large boils are formed. The water and sand rushes out with considerable force and it is evident that something is happening which may be producing injury to the bed if it continues for any length of time. Fortunately these large boils usually disappear as soon as the sand becomes expanded, which requires from 30 to 60 seconds. Figure 15 illustrates what takes place in one of these large boils. The illustration shows the beginning of a boil in a filter bed about 2 feet in depth of sand. The boils which extend through the bed to the sand surface are unlike the jets which have been described, in that the wash water comes from a large area of the gravel instead of a very small area, as is the case for the jets.

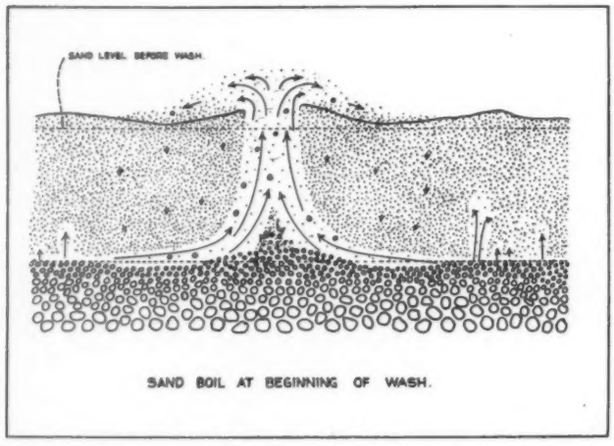


Fig. 15—An Illustration of What Takes Place in a Large Sand Boil

Unless the wash water is turned into the filter very slowly, the bed does not have time to become expanded from top to bottom. The rate at which the wash water is being forced through the gravel is enough to partially suspend the sand, so the sand next to the gravel becomes expanded while there is little or no expansion of the sand in the upper part of the bed. Soon 80 to 90 per cent of the bed which is unexpanded is floating on top of an expanded layer next to the gravel. Sand with 45 per cent voids filled with water will have a weight of about 119 pounds per cubic foot, which is approximately 1.9 times the weight of water. If the thickness of unexpanded sand is 20 to 24 inches, there is considerable difference in the weight of material in the unexpanded portion compared with that of the expanded material. As soon as the water breaks through at points, the water and sand in the expanded part of the bed rushes to these points with considerable velocity, and sufficient to move material of considerable size. This produces mounding of the gravel underneath the boil. Where there is uniform distribution of the wash water in the gravel, the boils generally do not occur at the same place, and the mounding produced at one washing of the filter usually is not enough to greatly disturb the gravel layer. If there is some point in the underdrains where the wash water can come out more easily than at other poitns it tends to form a boil in the same place each time. Soon there is considerable mounding of the gravel at the point. It is not uncommon, when the sand is removed from a filter bed which has been in service for a few months or longer, to find mounded places where the gravel is one foot higher than it is at the lower points. All of the fine gravel for some distance around the mound has been pulled over to the mound.

It is known that the pressure of the wash water, when the water is first turned on a filter, usually rises to a point higher than prevails after the bed becomes expanded. During the time it is lifting the unexpanded material it has to lift the weight of the sand and water within the pores of the unexpanded portion, whereas after the bed becomes expanded it is lifting only the sand. This increase in wash water pressure is especially noticed in filters where the wash water is turned on fairly rapidly. It is believed that opening the wash water valve slowly is better than opening it rapidly.

Effect of Mud Balls.—In Part 4 conditions were illustrated under which mud balls sink in the sand to the gravel layer, though it was not stated what finally became of them. Most of them are gradually worn away by abrasion of the sand grain during washings until they became so small they are again washed to the surface. If mud balls are produced but the filter beds never form clogged places, it is due to the fact that the mud balls become worn away without clumping together. There are several factors aiding in the formation of mud balls, such as the amount and kind of coagulated matter going to the filter, the fineness of sand grains, and the manner of washing. Assuming that the water has been well coagulated, has passed through settling basins with several hours capacity, and that the washing system underneath the sand bed is perfect, there still are many filtration plants where clogged areas will form in the filter beds. It is not known definitely if it is the adhesiveness of the mud

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*Note: This is the second half of Part 5 which deals with the question of "The Sand-Gravel Interface." The first half appeared in the March issue.—Editor.

balls, the number being formed, or some other cause which produces clogged areas. The fact remains that such places form where the design of the plant and the treatment of the water are thought to be all right.

Enough of the finer sized filtering material becomes entrapped in the coagulated material filtered from the water to cause it to agglomerate and settle to the gravel layer. These mud balls are piled up during the wash in places where the sand descends between the points where there is jet action. After the wash water is cut off, the weight of the sand and water pressure mashes them together enough to make them adhere in some instances. This, of course, does not take place in one operation, though eventually two or three mud balls get mashed together so firmly that they remain attached. Then some time later other mud balls get mashed against these two or three, and so on until a large mass has united. It may be weeks or even months after the mud balls have accumulated at the bottom before they become bound together cohesively. When an area of several square inches becomes clogged, practically no water passes through the area. Then there will be a column of sand which is not expanded during washing which extends upward from the clogged area for perhaps 10 or 12 inches, or even more in some instances, depending on the size of the clogged area. The column is not a rigid one, except that it gradually builds up as such from the bottom towards the surface, due to accumulation of more mud balls. It is usually only the bottom part of the clogged area that contains a large percentage of mud, for it does not require much binding of the filtering material to hold it together if the bottom is bound firmly. Once the clogged area is started at the gravel surface it builds up rapidly.

Instead of the clogged mass resting upon a raised portion of gravel, as it would seem that it should, it is usually found sunk below the original gravel surface. This is caused by the cross flow of water at high velocities gradually pushing the finer gravel from under the mass and also to shifting of the ridged areas in the bed. Where there are clogged areas, the high places in the gravel may be where jet action is taking place instead of between the jets as is the case before the clogged areas are found. A stone several inches in diameter placed on top of the sand in a filter bed will sink to the gravel layer during washing, and within the course of time will be found embedded an inch or more into the gravel. This is what happens with the clogged area, except that the specific gravity is not as great as that of the stone and the process of sinking into the gravel is not as rapid. A surface wash system prevents formation of mud balls and clogged areas, and it seems that this should be much more desirable than to allow them to grow and produce filter bed troubles.

Large Areas of Mounded Gravel.—It has been found in various filtration plants throughout the country that upon removing the sand from filter beds which have been in service for several years the gravel surface in some of the beds has been disturbed considerably. Occasionally large areas are found in filters in which the gravel is several inches higher, and at other places lower than it was when the bed was originally constructed. A number of the early filters were constructed with a center manifold in which the lateral pipes were placed level with the bottom instead of the top of the manifold, somewhat as shown in Figure 16. Strainers were inserted in the top of the manifold as shown by the illustration, and were several inches higher than the strainers in the laterals. It is believed that the wash water was not distributed uniformly over the bed in many of these filters, for so many of them have given

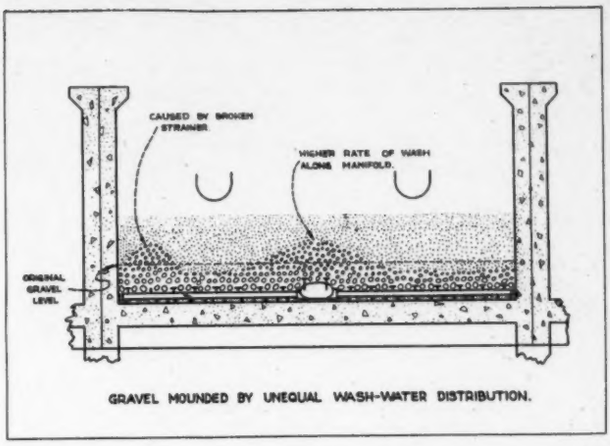

CAUSED BY BROKEN STRAINER
HIGHER RATE OF WASH ALONG MANIFOLD
ORIGINAL GRAVEL LEVEL
GRAVEL MOUNDED BY UNEQUAL WASH-WATER DISTRIBUTION.

Fig. 16—The Resulting Gravel Mounds Caused by Uneven Wash Water Distribution

trouble. There must have been a greater volume of the wash water passing through the strainers on the manifold to cause the mounding shown in Figure 16. Regardless of what happened in the underdrains, more wash water came up through the sand along the line of the manifold than over the rest of the bed.

When air is used to aid the filter wash, the rate of applying the wash water usually is less than 15 gallons per square foot per minute. It would seem that this low rate of wash is not sufficient to disturb the gravel, yet, as many are aware, the gravel is drawn towards the manifold and becomes ridged sometimes as high as 12 inches in extreme cases. It is probable that the formation of clogged areas has aided the mounding by increasing the rate of flow through the clean parts of the bed. After the fine gravel has been moved to the ridged places, sand then comes in contact with the coarser gravel in parts of the bed. The manifold with pipe laterals coming out at the bottom is not used extensively at the present time, and it probably should be abandoned entirely. There may be units constructed in this manner which have never given trouble, but so many of them have, that the design is believed to be at fault.

Probably everyone who has operated a filter plant over a fairly long period has had trouble with fairly large mounded areas of gravel forming in parts of the bed not over a manifold. The cause may be a break in one of the strainers, or to an opening of some kind in the under-drains, such as a broken lateral. Such breaks may cause mounding of the gravel for an area of several square feet if it is allowed to run for a few weeks. Usually a break like this causes such rapid flow of water at the point where the break occurs that unusual boiling of the sand is noticed and the break is repaired. In all cases where there is mounding of the gravel over a fairly large area, and the filter bed is free from clogged places, the cause can be attributed to more wash water passing through that point than through the surrounding area. The extreme case illustrated in Figure 16 shows that the fine gravel may travel a considerable distance in the bed within the course of time. It is moved by some force not generally regarded as being capable of moving the gravel. It can be nothing other than the great velocity of the wash water passing across the surface of the gravel to the point where there is a boil in the sand bed.

To give some idea of how gravel may become disturbed in the ordinary routine operation of filters, measurements of the level of the gravel in Filter No. 1 at the Chicago Experimental Plant were made. The filter

is 10 feet by 10 feet in surface area. It was not operated continuously, and at the time the measurements were made, the total operating time amounted to about 9.5 months. There was a maximum variation of 9 inches from the lowest to the highest points. The top layer of gravel used in the filter was 3 inches of material retained on a ⅛-inch screen after passing a ¼-inch screen. With the unevenness found, it is evident there were places where the top layer of gravel had been completely washed away and piled up in other parts of the filter.

Grading of Coarse Material in Filters.—What has been found by experimenting with the grading of filtering materials indicates that more consideration should be given to the subject. A gradual transition from the coarser to finer materials is believed to be better than the gradings used in many filter beds. Heretofore very little consideration has been given to the coarse material in the filter sand; that is, the material between the 60 per cent size of the sand, and the gravel. As there is no well defined custom of distinguishing between sand and gravel for filter beds, it seems necessary to assume some size for the dividing line. It was stated in another paragraph that all material which was retained on the 10-mesh standard sieve was classified as gravel, and that all which passed this size sieve was classified as sand. This dividing line is suggested as being suitable for rapid sand filters. The largest size grains passing the 10-mesh standard sieve used by the writer were approximately 2.1 mm. diameter. The main reason for selecting this as the dividing size is that material coarser than this size should be screened and placed in the filter bed in layers in advance of the addition of the sand. Materials less than this size need not be placed separately from the sand, for if it is mixed with the sand it will grade itself properly when the filter is washed.

Observations on glass tube and glass side filters indicate that there is less jet action with a gradual change from coarser to finer material than where there is an abrupt change in size. There appears to be no grading which may be used that will avoid the jet action, but it is believed desirable to limit it as much as possible. The deeper layers of fine gravel and coarse sand do not allow as great a volume of wash water to pass through individual void openings in the gravel as is the case where the water flows through fairly coarse material directly into the sand being suspended by the wash water. It is believed that a very good grading for all material over 1.0 mm. diameter is in accordance with equation

$$M = K \log D \quad (8)$$

M = Depth in inches below the material of 1.0 mm. diameter.

K = Constant.

D = Diameter of particles in millimeters.

The value of K should be between 10 and 14 for most filters, and it is believed that 12 will give a very good grading of the material. Table 17 shows the distance the various sizes of material should be below the line of 1.0 mm. material, assuming theoretical grading according to size.

TABLE 17

Diam. of particles in mm.	Inches below 1.0-mm. size
1.0	0.0
2.0	3.6
4.0	7.2
8.0	10.8
16.0	14.4
32.0	18.1
38.0	19.0

The bottom layer of material cannot be computed by the equation. Many filtration plants use material from 38 to 51 mm. in diameter for the bottom layer. The depth varies from 4 to 10 inches. There are several factors which govern the thickness which the bottom layer of material should be; such as the size, kind and spacing of the underdrains, so this thickness will have to be decided upon for the particular condition. The equation is suitable for determining the sizes and depth of materials above the bottom layer. It assumes a gradual transition of sizes, which of course cannot be attained exactly, owing to the necessity of using sizes ranging between two screen sizes. The openings in the screens should not vary very much, and the next finer screen should have openings which give particles at least one-half the diameter of the next larger size. If the material in the layer next above the bottom layer passes through a 38-mm. screen, the next smaller screen should be not less than 19 mm. The table shows results in millimeters, whereas most sieves have openings expressed in inches or fractions of an inch. Select standard sieves, determine the size of opening in millimeters, and then make the thickness in the bed in accordance with that given by the equation. If it is desired to have about 5 inches of material from 38 to 51 mm. in diameter at the bottom, *the total depth of material larger than 1 mm. in diameter should be about 24 inches.* This depth may be made less by using a smaller constant in the equation, but it is believed advisable not to use a figure which will give considerably less depth of gravel. There is bound to be some ridging of the material and the variation in sizes should not be so great that the maximum ridging effect will allow the sand to reach gravel coarse enough for it to pass through.

It is believed that the grading suggested will avoid sand and gravel becoming mixed if there is uniform distribution of the wash water over the bed. Should there be places where more wash water comes up through the gravel than the average for the bed, it is likely that the coarse sand and gravel will form mounds at such points. There probably is no way in which the formation of mounds can be avoided with unequal distribution of wash water.

Amount of Coarse Sand Needed.—It has been stated that all material larger than will pass through a 10-mesh standard sieve should be sieved and placed in layers of the desired thickness. In addition to this, there should be a substantial amount of material between 1.0 mm. diameter and the largest size passing through a 10-mesh sieve which need not be screened. There probably will be very few filter sands which contain enough of the coarse material, and it may be necessary to use two sands to obtain the desired proportions. One of the sands should be known as the regular filter sand and the other the coarse sand. Enough of these sands should be used to obtain the desired depths of material less than 1.0, and the desired depth between 1.0 and 2.1 mm. diameter.

Assume that it is desired to have 20 inches of sand less than 1.0 mm. diameter and that it is desired to have the coarse material graded according to the equation

$$M = 12 \text{ Log } D.$$

M = Thickness of material in inches between 1.0 mm. diameter and diameter D, assuming the material graded according to size from the 1.0 mm. diameter.

D = Diameter of coarsest material in millimeters classified as sand.

If the 10-mesh sieve gives 2.1 mm. diameter for the largest size particles passing the sieve, there should be enough material between 1.0 and 2.1 mm. diameter to

make a layer 3.87 inches thick in the filter bed. Assume that the regular filter sand contains 6 per cent of its weight which is over 1.0 mm. diameter and less than 2.1 mm. Also assume that 80 per cent of the coarse sand is over 1.0 mm. diameter and 20 per cent is less than this size, it would not be difficult to compute the proportions of each sand to use in the bed.

(9) $L + K \log D$ = total depth in inches of sand less than 2.1 mm. dia.

(10) $PL_2 + P_1L_1$ = inches sand 1.0 to 2.1 mm. dia. = $K \log D$

(11) $(1\text{-}P)\ L_2 + (1\text{-}P_1)\ L_1 = L$

L = Depth of sand in inches 1.0 mm. dia. and less.

L_1 = Depth in inches of regular filter sand in use.

L_2 = Depth in inches of coarse sand to use.

K = Constant. Assumed to be 12.

D = Diameter of sand or gravel particles in mm.

P = Percentage of sand over 1.0 mm. dia. in coarse sand, expressed as decimal (80 per cent = .80).

P_1 = Percentage of material in fine sand over 1.0 mm. dia., expressed as decimal (6 per cent = .06).

As $PL_2 + P_1L_1 = K \log D$, its value can be computed. Then equations 10 and 11 equal known values. P and P_1 also are known, being determined by screen analysis. It is not difficult to reduce the equations to one unknown and compute its value. Computation of the amounts of each sand to use is as follows:

$K \log D = 3.87$ inches, when $K = 12$ and $D = 2.1$

(a) $PL_2 + P_1L_1 = 3.87$

(b) $(1\text{-}P)\ L_2 + (1\text{-}P_1)\ L_1 = 20$ (assumed depth of sand less than 1.0 mm. dia.)

$P = .80$

$P_1 = .06$

(a) $.80\ L_2 + .06\ L_1 = 3.87$

(b) $.20\ L_2 + .94\ L_1 = 20$, or $.80\ L_2 + 3.76\ L_1 = 80$

Subtracting (a) from (b)

$.80\ L_2 + 3.76\ L_1 = 80$

$.80\ L_2 + .06\ L_1 = 3.87$

$3.70\ L_1 = 76.13$

$L_1 = 20.58$

$L_2 = 23.87 - 20.58 = 3.29$

There should be 3.29 inches of the coarse sand and 20.58 inches of the regular sand used to give 20 inches of sand less than 1.0 mm. dia., and 3.87 inches of sand between the sizes of 1.0 and 2.1 mm. dia.

High Specific Gravity Material.—Consideration has been given to the use of high specific gravity material for the upper part of the gravel. It is believed that the high specific gravity material can be limited to sizes less than 12 mm. in diameter. It may be possible to start with material only 6 to 8 mm. in diameter, but it should be well demonstrated that this size is large enough before constructing beds with this as the largest size for such material. It is believed that the thickness of the layers of high specific gravity material may be made less than is required with gravel. Very encouraging results have been obtained with the use of magnetite and iron oxide. These materials have a specific gravity close to 5.0. The iron oxide used was not very hard and it has not been in service long enough to determine if it will have a very long life. The magnetite, which was mined material, was fairly hard and it is believed will be durable. Since there has been so much trouble from the gravel becoming uneven in filter beds, it is believed that consideration should be given to the use of high specific gravity materials. Additional experiments have been planned and it is hoped to get them under way in the early part of 1935.

Porous Plate Bottoms.—Experiments are under way elsewhere on the use of porous plates for filter bottoms. There is no doubt about such plates being satisfactory at first, but the writer fears the danger of clogging. If plates can be produced which will not clog within a few years' time, then it is believed such a bottom will have advantages over the graded gravel bottom.

Summary

The formation of sand boils when the wash water is first turned on a filter bed produces conditions likely to seriously disturb the top gravel layer. This is due to the rapid rush of water horizontally across the surface of the gravel towards the boil.

Mud balls accumulating at certain points in a filter bed frequently stick together and start the formation of clogged areas. The clogged areas always rest upon the gravel layer, or stick to the side walls of the filters. Those which rest upon the gravel may cause disturbance of the gravel when the filter is washed.

Large areas of mounded gravel are caused from unequal distribution of the wash water. It is not uncommon to find the gravel mounded to the extent that it is 10 to 12 inches higher than the surrounding gravel. Breaks in the underdrains and improperly designed underdrainage systems are largely responsible for mounding of the gravel.

A more gradual transition in the sizes of the materials of a filter bed from coarse to fine is believed preferable to the grading now in general use. An equation for computing the proper thickness of the various materials is given.

Material which will be retained on a 10-mesh standard sieve should be classified as gravel, and should be sieved and placed in the bed in layers.

The suggested grading requires more coarse sand and fine gravel than is customarily used in filter beds. A method of computing the amount of coarse and fine sand to add to a filter to obtain the proper depths of the various sizes is given.

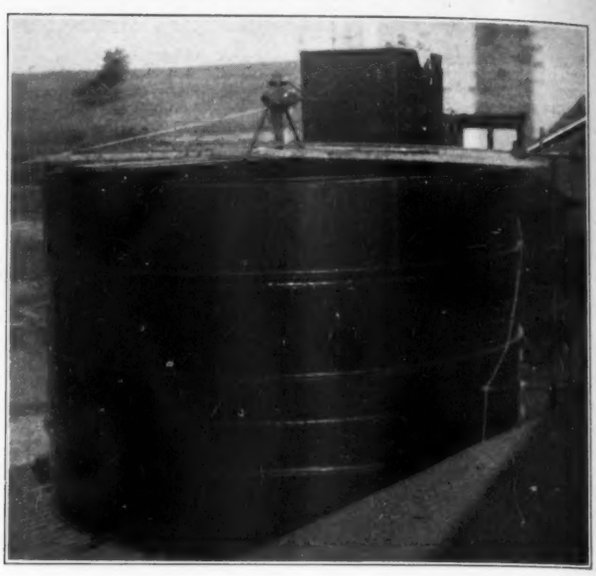
Experiments on the use of high specific gravity material, such as magnetite, in place of the finer layers of gravel gave encouraging results in glass side and glass tube filters.

▼

An Acknowledgment

In the picturized section of "Representative American Water Works Plants" in our April issue on page 155 appeared a picture of the Pumping Station and Filtration Plant at Saginaw, Mich. The firm of engineers credited with the design was Hoad, Decker, Shoecraft, Drury and McNamee of Ann Arbor, Mich. It was intended that this firm be credited with the design of both the Saginaw and Fort Wayne plants.

As to the Saginaw plant this firm were co-consultants with Maury & Gordon (now Gordon & Bulot) of Chicago. H. H. Eymer, City Engineer of Saginaw, was not only in charge of the entire project but also handled all of the detailed supervision of construction with his own organization. Our failure to properly credit both firms and Mr. Eymer is regretted and we take this opportunity to acknowledge and apologize for the mistake. —Editor.



Chlorinating - Precipitation Tank (5,000 gal. cap.) at Grand Rapids Packing Co.'s Plant, Grand Rapids, Mich.

MEAT PACKING PLANT WASTE TREATMENT

A Study of Efficiencies of Coagulants and Costs

By E. F. ELDRIDGE

Engineer, Experimental Station, East Lansing, Michigan

E. F. Eldridge

THE outstanding development in the treatment of meat packing wastes by chemical coagulation is that reported by Halvorsen and others (1, 2, 3, 4), resulting from studies made at the Geo. A. Hormel & Co. packing plant at Austin, Minn. After having attempted the use of various chemicals it was found that chlorine, in large dosages, was a most satisfactory, efficient and economical precipitating agent for this waste. This process was not only reported as effective in removing 85 per cent of the B. O. D., but resulted in recovery of a portion of the operating expenses through the sale of the sludge as a fertilizer.

At the request of the Grand Rapids Packing Co., the Michigan Experimental Station attempted a similar study, except that the problem was complicated by having to deal with a stronger waste of much smaller volume. The results obtained, in respect to the evaluation of the effectiveness of various coagulating chemicals, were identical with those reported by Halvorsen. The next problem was the design of a plant which could be easily and effectively operated, on a part time basis, by a person untrained in the use of chlorine and the mechanism of the coagulation process.

The Waste and Its Disposal

The Grand Rapids Packing Co. had for a number of years experienced considerable trouble from the disposal of the liquid wastes from the killing floor of its slaughter house. The use of a large septic tank for the retention of the waste proved unsatisfactory. Ponding in a lagoon caused such an odor nuisance that this method was abandoned. The only other scheme of disposal available was the direct discharge of the waste into a small stream.

The waste is composed of the washings from the killing floor. These wastes contain considerable blood and some manure. The total volume of waste produced during the 8 hour working day was about 5000 gallons. The average 5-day B. O. D. was 2000 p.p.m., the organic solids being largely blood proteins.

Laboratory Studies

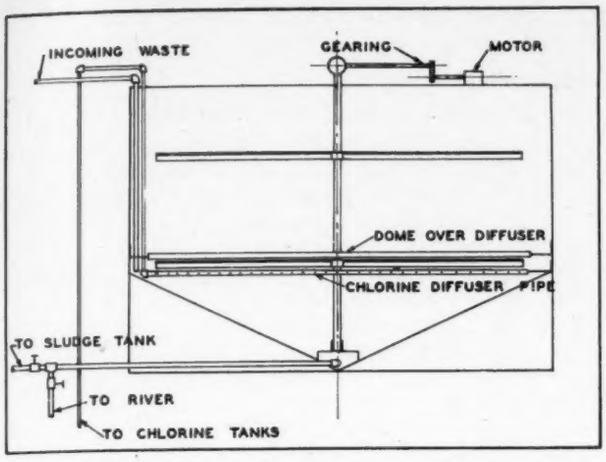
The laboratory studies consisted of the use of various coagulants, in an attempt to establish the relative merits of each. Various acids, lime, sodium and calcium hypochlorites, alum, ferric chloride, ferric sulphate, and chlorine were tried.

One of the first requirements proven was that coagulation must take place in an acidic medium. This immediately eliminated the use of lime and the alkaline hypochlorites. Alum produced a voluminous floc, which was too light to settle and consequently was eliminated from consideration.

With the exception of chlorine, ferric chloride and ferric sulphate gave the best results. Both of these iron coagulants produced a heavy floc which settled rapidly and formed a dense sludge. However, they could not be depended upon to produce consistently satisfactory reductions in B. O. D. values, as is indicated in Table I.

TABLE I—FERRIC CHLORIDE TREATMENT OF PACKING HOUSE WASTES

		——5-Day B. O. D.——			— Total Nitrogen—		
Sample No.	$FeCl_3$ p.p.m.	Raw p.p.m.	Treated p.p.m.	Reduced %	Raw p.p.m.	Treated p.p.m.	Reduced %
1.....	256	1410	533	68.2	292	102	65.5
1.....	342	1410	281	80.2	292	60	79.6
2.....	256	2290	2006	12.4	618	516	16.5
2.....	342	2290	1580	31.0	618	530	14.2
2.....	427	2290	950	58.5	618	426	31.1
3.....	427	2000	600	70.0	533	280	47.5



Sketch of a Section Through the Chlorinating and Precipitating Tank

Adjustment of the pH over a wide range, prior to the addition of the ferric chloride, gave no appreciable improvement in the removal or saving in the amount of coagulant added. The particular disadvantage in the use of the iron salts other than the inconsistency of results was in the relatively large volume of sludge produced.

Chlorine applied as a gas by means of glass diffusers gave consistently satisfactory results in all of the laboratory studies. Reductions in B. O. D. averaging about 90 per cent were obtained. The best removals were obtained when sufficient chlorine was applied to give a residual of 40 to 50 p.p.m. in the supernatant liquor after precipitation.

Design of the Full-Scale Plant

Based on results from the laboratory studies, it was decided to build a full-scale precipitation plant designed to utilize chlorine as the coagulant. In order to minimize the labor required for the operation of this plant it was designed on the fill and draw principle. The plan was to impound the waste in the tank during the day, then apply the chlorine and precipitate after the factory closed. The clarified supernatant was discharged and sludge drawn the following morning and the tank returned to service for impounding that day's wastes, thus necessitating but the single tank in the scheme.

This plant consisted of a 5000 gal. galvanized iron tank, 12 feet in diameter and 8 feet deep. The lower 3 feet was cone shaped leading to a 3-inch drain pipe at the bottom.

Chlorine was supplied from four 150-pound chlorine cylinders connected by means of hard rubber pipe to a perforated rubber pipe in the bottom of the tank. (Alundum diffusers which were originally installed in the tank proved unsatisfactory due to the fact that they plugged completely. This was apparently due to the entrance of the waste after the chlorine pressure had been removed. Trouble was experienced even after the very first run.)

Much improved coagulation was effected through stirring by means of two horizontal paddles operated from a vertical shaft. The speed of these paddles was regulated to give a swirl velocity at end of the horizontal paddle of about 25 feet per minute.

A satisfactory arrangement for the disposal of the sludge has not been developed to date. At present it is being drawn into the septic tank which has a capacity for about 6 months' supply of this sludge. The tank will require a complete cleaning and hauling away of this non-putrescible sludge at the end of that period.

The accompanying sketch represents a section through the tank and equipment. Pictured also is the tank before it was housed in.

Full-Scale Plant Results

Trial runs were made with the full-scale plant using both ferric chloride and chlorine individually, and finally in combination. The method of operation originally planned was followed.

Results of Ferric Chloride Application—The same inconsistency in the results was obtained from the use of ferric chloride in the full-scale plant operation as was experienced during the laboratory studies. It was found that the quality of the waste treated was an influencing factor. For instance, as long as beef stock was being slaughtered, ferric chloride gave fairly good removals. As soon as a change was made to hogs, however, the results were poor regardless of various adjustments of the ferric chloride dosages applied. This circumstance can apparently be explained by the presence of a larger quantity of blood and much less manure in the waste which is the condition during hog killing. Since ferric chloride does not have the property of coagulating blood proteins as does chlorine, there is a definite limit to the removal of oxygen demanding materials by ferric iron coagulants when applied to certain slaughter house wastes.

The average B. O. D. of the waste produced from the killing of cattle was 2700 p.p.m. This was reduced by ferric chloride coagulation to 420 p.p.m., representing average reduction of 84.5 per cent. The average B. O. D. of the waste when hogs were killed was 2450 p.p.m. This was reduced to only 1070 p.p.m. by ferric chloride, a reduction of 56.3 per cent—see Table I.

The average amount of absolute ferric chloride ($FeCl_3$) required for maximum results was 360 p.p.m. About 500 gallons of sludge was produced from the 5000 gallons of waste—i.e., 10 per cent by volume. (See later results with chlorine aided by ferric chloride.)

Results of Chlorine Application.—The inconsistencies so apparent with ferric chloride were not experienced

Packing House Waste as Received (Left) and as Turned Out of the Grand Rapids Packing Co.'s Treatment Plant at a Cost of $1.50 *Per Day*

when chlorine treatment was applied. Some difficulty was experienced, however, with the settling of the sludge, which is light, due to grease content and a minute gas bubble, and does not concentrate well. This trouble was corrected by the addition of a small amount of ferric chloride *after the floc had first been formed with chlorine*. With this combination a well clarified supernatant liquor and well concentrated sludge was obtainable with about 2 hours' settling.

Chlorine was applied to the tank of accumulated waste at a rate which gave the least loss of the gas at the surface. An average of about 2.5 hours were required to complete the chlorination, which was stopped when 40 to 50 p.p.m. residual appeared in the clear liquor. The ferric chloride was then added and the mixture stirred for about 20 minutes. After standing over night, the sludge was drawn and the supernatant liquor discharged.

The average quantity of chemicals applied to the waste over the period of about six months, since the plant was placed in operation, has been 334 p.p.m. chlorine and 50 p.p.m. ferric chloride. The average B. O. D. of a number of samples of the impounded waste during that period has been 2140 p.p.m. and B. O. D. of the effluent only 150 p.p.m., representing an average reduction of 92.6 per cent. Residual chlorine determinations made on the effluent samples (supernatant liquor after standing over night) averaged 44 p.p.m.

The volume of sludge produced per 5000 gallons of waste, estimated by measuring the drop in elevation in the tank, was 228 gallons. This is considerably less than the volume resulting from the use of ferric chloride alone. The analysis of composited sludge samples showed an average of 7.1 per cent dry solids of which the volatile matter was 91.8 per cent and the nitrogen content 11.6 per cent—both being on a dry solids basis.

Samples of the slaughter house waste, here pictured, before and after treatment with chlorine, assisted by ferric chloride, are self asserting as to the visible effectiveness of the process. Laboratory results to the chemist are equally impressive as is the simplicity and comparative cost of treatments to the meat packer.

Discussion

In order to get a better idea of the results accomplished and the cost of chemicals required for this type of treatment, the above results may be set up on a million gallon basis. Because of the inconsistencies obtained with ferric chloride, it is difficult to compare the results obtained by the use of the two coagulants. An attempt has been made to do this, however, in the following tabulation, using the average results from ferric chloride coagulation, regardless of the type of waste treated:

FERRIC CHLORIDE

B. O. D. removed ..... 11,900 pounds per M. G.
Ferric chloride required ..... 3,000 pounds per M. G.
Cost of $FeCl_3$:
(a) Car lots at 5c per lb. ..... $150.00 per M. G.
(b) Tank car lots at 2c per lb. ..... 60.00 per M. G.

CHLORINE

B. O. D. removed ..... 16,540 pounds per M. G.
Chlorine required ..... 2,780 pounds per M. G.
Cost of Chlorine:
(a) In 150-lb. cylinders at 7c per lb. .. $194.50 per M. G.
(b) In ton containers at 2c ..... 55.60 per M. G.
Cost per 100 lbs. of B. O. D. removed { (a) By $FeCl_3$ (tank car prices) = 50c; (b) By chlorine (ton containers) = 33c

According to this cost analysis the cost of ferric chloride per million gallons is only about 7.3 per cent greater than chlorine. However, on the basis of actual work accomplished in B. O. D. removal the cost of ferric chloride is actually 51 per cent greater than chlorine and is also less effective as the proportion of hog killing waste increases.

Conclusions

The conclusion to be drawn from these studies follow:

(1) Ferric chloride coagulation when applied to slaughter house wastes gives inconsistent results because it does not have the property of completely coagulating blood proteins.

(2) Chlorine treatment if properly applied results in the removal of more than 90 per cent of the B. O. D. and will give consistently good removals.

(3) A small amount of ferric chloride added, *after* the chlorine coagulation, aids in settling the floc and concentrating the sludge.

(4) Chlorine treatment may be applied successfully at small packing plants as well as at large ones.

(5) Chlorine for such treatment is less costly than ferric chloride. Especially so when compared on the basis of purification attained per dollar of cost.

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Cleaning Wells with Inhibited Muriatic Acid

In our May issue an article by Abrams and Wagner described methods and results from the use of inhibited acid for cleaning out clogged metallic pipes. The following is another instance of the use of inhibited acid in water works practice:

To restore a flow that had dropped from 500 gallons to 70 gallons per minute in one of the wells of the Woburn, Mass., water works system, the well screen, obstructed with foreign matter, was recently cleaned with inhibited muriatic acid. Examination of samples of the encrustation revealed that it was largely manganese dioxide that had been apparently deposited by bacterial growth.

Inhibited muriatic acid, supplied by Merrimac Chemical Co. of Boston, Mass., was used. The inhibitor prevented undue corrosive action on the metallic parts without interfering with the chemical action of the acid on the encrustation. The acid water was run through crushed limestone as it came out of the well and by this means was neutralized before discharge to waste.

The cost of the cleaning was far less than that of installing a new screen which would otherwise have been necessary, and the original well yield of 500 gallons per minute was restored.

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Burns & McDonnell Open Offices at Albany, N. Y.

The Burns & McDonnell Engineering Co., have established a permanent engineering office in the Home Savings Bank Building, Albany, N. Y., in order to serve its clients in the East.

The new office will be in charge of Hartwell J. Rosson, who was formerly in charge of the Cincinnati office, now in charge of M. C. Bartlett.

Burns and McDonnell advise that they now have work in progress at Yonkers and Auburn, N. Y.; Newport, R. I.; Cumberland, Md., and New Castle, Pa.

Maryland-Delaware Water and Sewerage Association

MEETING OF MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION

Governor of Maryland Principal Banquet Speaker

THE 9th Annual Conference of the Maryland-Delaware Water & Sewerage Association was held in the historic State House at Annapolis, Md., May 16th and 17th. The official registration was 128.

On the evening of the 16th, 121 members and guests attended the annual dinner held in Carvel Hall at which the principal speaker was the Honorable Harry W. Nice, Governor of Maryland, who was introduced by Abel Wolman, Chief Engineer of the State Department of Health. Following the dinner there was dancing.

The second afternoon was devoted to trips of inspection to the new garbage incinerator, the extensive Annapolis sewerage project under construction, water filtration plant and the Naval Experimental Station. In charge of arrangements and program was B. E. Beavin of the Annapolis Sewerage Commission, to whom credit is due for the smooth running of entertainment, inspection trips and meeting facilities.

Officers named for the ensuing year are:

President—L. D. Shank, City Manager, Dover, Del.

Vice-Pres.—J. V. Cannen, Supt. Filtration, Hagerstown, Md.

Vice-Pres.—E. S. Hopkins, Asst. Supt. Filtration, Baltimore, Md.

Sec'y-Treas.—A. W. Blohm, State Dept. Health, Baltimore, Md.

The Brass Hats

From Left: C. J. Lauter (Washington), Retiring President. B. E. Beavin (Annapolis Sewerage Commission), Host. L. D. Shank (Dover, Del.), Incoming President

Elected to the Executive Committee was: George E. Harrington of Dalecarlia Filters, Washington, D. C.

The 1936 Conference was voted to Frederick, Md.

Technical Sessions

(*President T. J. Lauter, Presiding*)

Mayorally welcomed by Annapolis' Quenstedt, the technical sessions were opened with a description of "The Annapolis Incinerator" by L. J. Houston, City Manager, Fredericksburg, Va. Discussion was contributed by J. E. Jackson, of the Pittsburgh-Des Moines Steel Co., builders of the incinerator, and Dr. J. H. Janney, County Health Officer.

JAMES R. MCCOMAS, of the Maryland Department of Health, in advocating **"Comprehensive Plans for Water Supply and Sewerage in Maryland,"** suggested a 30 to 50 year plan of zoning, street grading and location, with a definite program of stage-development involving projects arranged in chronological order of future necessity. Discussion was contributed by *W. H. Corday* of Gannett, Eastman & Fleming, Engrs., and *R. L. Burwell,* Chief Engr. of the Annapolis Sewerage Commission.

A report and review of accomplishments of the "Operators Short School," held under the auspices of the association early in the year, was presented by Professor EDW. S. HOPKINS.

Pertaining to Corrosion Control

The afternoon session opened with a paper by W. C. Stewart, Metallurgist, U. S. Naval Engineering Experimental Station, in which he described methods used in testing the corrosion resistance of pipes, shafts, bearings and the like constructed of various metals and alloys. Also the effect of galvanic action at junction points of different metals had been studied. Unfortunately, few of the tests could be directly connected with water works practice and therefore this valuable paper was of but limited interest to the audience. The title included reference to testing of corrosion resistance of "Transite" pipes vs. Cast-Iron et al., but there was little or nothing presented to cover this phase of the work, if such had ever been done.

A. W. Blohm (Md. Dept. Health), Secy.-Treas. (Left). Miss Gipe, Official Recorder and Secretary to Maryland Chief Engineer. George Hall, Who Runs the Office of the Engineering Division of Maryland's Dept. of Health

The paper was discussed by K. H. LOGAN of the U. S. Bureau of Standards, who referred to studies of soil corrosion of pipes in which copper bearing steels had not proved superior to ordinary steel pipes. "Transite" had also shown signs of deterioration from soil attack along with other materials. The better use of protective coatings seemed to be the most promising developments in pipe protection against both interior and exterior (soil) corrosion, but, he added, minimum wall thickness could not be ignored. In bituminous coatings, the material employed and thoroughness of application were the most important factors, and these should be carefully specified and specifications enforced rigidly.

F. N. SPELLER, Director of Research, National Tube Company, referred to the efficacy of interior pipe linings consisting of cement and asbestos fiber and the long life of such linings in steel pipes. He commented on the New York studies (reported elsewhere in this issue) which revealed no more resistance offered by wrought-iron than by steel pipes. He advocated greater consideration of corrosion control by water treatment. He said that a new scheme of producing economical but resistant pipe was that of a steel shell (for strength) lined with thin copper sheeting to effect corrosion resistance.

(The reader will find it of value to examine the Symposium on Corrosion presented before the A. W. W. A. and reported elsewhere in this same issue.—*Editor.*)

H. E. BECKWITH, District Manager of the Pitometer Company, contributed interesting observations indicating that certain cement lined mains which had been tested by his organization after 60 years' service still had a coefficient of 105, whereas unlined cast iron mains in the same system had so suffered from tuberculation as to have a coefficient of only 48. He was convinced that greater recognition was due cement lining or other interior coatings for insured permanency of pipe line capacities, making long term planning dependable with maximum returns from investments in water mains assured.

L. H. ENSLOW, in commenting on the lime treatment of soft waters to produce an alkaline and less aggressive water, said it was difficult to predict the minimum effectiveness of pH value in advance. The need in some instances was to go up as high as pH 10 to stop corrosion when the water was extremely soft. This entailed a material hardening of a satisfactory soft water and that was obviously a questionable procedure. He could not agree with such practice and thought that a better scheme could be perfected by chemists who might give the problem further study which it justified. The cheapness of caustic soda (not soda ash) warranted its greater consideration in corrosion correction, either alone or in combination with lime. The net result would be a raised pH value with a resultant softening rather than a hardening effect. A second consideration involved the possible addition of a soluble calcium salt and soda ash (separately) which would create a reaction productive of a calcium carbonate depositing water. The added hardness would be "plated out" on the interior of the pipes to the desired extent. There was ample room for improvement in chemical treatment to protect household piping and reduce plumbing bills, which would bring credit to the water chemist. In some cases the use of lime alone had reduced corrosion of cold water services at the expense of clogging hot water coils and piping. Particularly was this noticed near the treatment station.

Economy of a Small Water Works

W. C. MONROE, Chief Engineer, Anne Arundel County Sanitary Commission, described a small water works involving a well supply, iron removal plant, standpipe and distribution system installed for a community (Pines on the Severn) with but 85 services. The system complete had cost only $16,688, which represented less than 12.5 per cent on assessed valuation of taxable properties. The annual operating cost would be about $930 per year. The per service cost would be about $11 for operations; other charges would result in a $21 overall cost per service. Treatment involved aeration, lime addition and settling, followed by pressure filtration to remove 42 p.p.m. CO_2 and 10 p.p.m. iron. Mr. Monroe considered $25 per service to be a fair cost of a water supply for such small communities.

M. H. COBLENTZ, of the Maryland Department of Health, pointed to the changing character of the well output with increased use. Aeration had removed 60 per cent of the CO_2 and settling removed 60 per cent of the iron. With usage the alkalinity had dropped and the organic matter had increased about 30 per cent, with the result that 11 grs. per gal. of lime had been recently required. Improving the aeration by installing coke

Prominent in the Maryland-Delaware Association

From Left: (1) *Robert Morse, Chief, and* (2) *Harry Hall, Assistant Chief, Washington Suburban Sanitary District.* (3) *Abel Wohlman and* (4) *R. C. Beckett, Chief Engineer of State Health Department of Maryland and Delaware.* (5) *J. W. Armstrong, Supt. Filtration Plants, Baltimore, Md.* (6) *J. W. Cannen, Supt. Filtration, Hagerstown, Md. (Vice President of Association).* (7) *G. J. Requardt, Construction Engineer of Baltimore, Md., in Charge of the Annapolis Project*

contact units and the use of a coagulant had cut the lime requirement in half. The 20-minute settling period following the 10-minute mixing tank had not been sufficient when pumping through the pressure filter against 187 lbs. pressure. It was now proposed to provide 1 hour of gravity settling.

The High Cost of Algae

GEORGE E. HARRINGTON revealed some **Interesting Experiences with Micro-organisms** in the raw water supply to the Washington filter plant in which algae growths had been responsible for extraction of large quantities of half bound carbon dioxide from the bicarbonates and a resultant rise in pH values of the raw water to pH 8.8. The organism predominating had been identified as the diatom synedra, resulting in markedly shorted filter runs (30 minutes at times), expense of increased wash-water to 10 per cent, and heavier alum dosage to cope with this organism and to neutralize the high pH in order to secure proper flocculation. The addition of sulphuric acid to the alum syrup proved to be the least costly procedure to secure effective coagulation. During the period when 50-hour filter runs had dropped to 4 or 5 hours 1 p.p.m. copper sulphate was added continuously to the raw mater pump suction line ahead of the coagulation basins. The algoe condition cleared up only to return again, but less pronouncedly. The experience proved more than just interesting when considering the cost of $1,749.33 for extra chemicals and wash water which was due solely to the vagaries of "a little diatom in a big pond."

J. W. ARMSTRONG, Filtration Engineer, Baltimore, Md., reported parallel experiences. He reviewed the observations at Coatesville, Pa., reported by Mr. Emigh in WATER WORKS AND SEWERAGE for August, 1934, and also their own at Baltimore. Studies at Baltimore had revealed that pH increases in the upper strata of reservoirs was chargeable against increased growth of bicarbonate splitting organisms. The depth to which such action had been traced was 34 ft. below surface and the critical temperature appeared to be 65 deg. F.

Operating Results at America's Most Unique Filter Plant

ROBERT B. MORSE, Chief Engineer of the Washington Suburban Sanitary District, and designer of the unique Burnt Mills, Md., filtration plant, reviewed experiences in its operation during its first year of service.

(Being impossible to adequately describe the plant in space here available, the reader is referred to the full description covered in an article by Mr. Morse to the found in WATER WORKS AND SEWERAGE for June, 1934.—*Editor.*)

The circular 5 m.g.d. unit, consisting of coagulation basin, rapid filters, and clear water storage, built of steel within a tank 100 ft. in diameter of all welded construction on a concrete base, cost only $11,000 per m.g. capacity—i.e., $55,000 for the first unit.

Mr. Morse listed as the principal novel feature its compactness. The four concentric tanks of steel (one within the other) comprised the four parts of the plant, all seams of which had been welded, some on both sides. The neat Williamson Selecto Filter Control Stands had taken the place of more cumbersome operating tables. The 4 "pie-slice" shaped filters, equipped with "Tri-lock" grating plate to serve as the under drain false bottom, had 16 inches of gravel under sand of 0.52 m.m. effective size. The net result was a very free filtering unit of exceptionally low head loss at rapid rates of filtration. Likewise, low wash water pressure and volume had been required—the wash rate being only 12 gals./sq. ft./min. and consumption at 1.7 per cent in March and 1.6 per cent in April. The tanks and filter shell of 5/16-in. steel plate had been protected with Bitumastic enamel which had adhered well and had not been cut through by the 11-inch ice cakes forming on the uncovered filters last winter.

Mr. Morse suggested the use of ungalvanized pipes for railings because paint had been found to adhere more firmly to raw steel. All buildings had been electrically heated, involving automatic thermo control. "Corkustic" insulation had been liberally used for sound proofing and insulating pump rooms. Roto Valves had been installed on pump discharge lines to maintain a constant coagulation basin level and a 55-minute divided semi-circular flow detention period. When the entire plant has been completed the costs will total $375,000 for the two 5 m.g.d. units and all buildings.

A. M. TAWNEY of Camp Meade, Md., said that he had spent two or three days at the Burnt Mills plant and was impressed with the operation and economy. He cited observed operation data and his directions as an operator were favorable. J. W. ARMSTRONG was particularly interested in the wash trough arrangements. Commenting on the enamel protective coating of the steel work, he said that his 20 years' experience indicated it entirely dependable when properly applied so as to prevent blisters and pinholes forming. Improperly applied, a creeping corrosion had taken place beneath the enamel surrounding imperfections.

"The Design of the Moore's Run Inverted Syphon"—by F. H. FIVORED, Bureau of Sewers, Baltimore, Md.

Mr. Fivored described an inverted syphon 2,761 feet in length, constructed of 18 and 24 inch Cast Iron pipe coated with Bitumastic Enamel. The unusual features included a grit chamber just ahead of the syphon to intercept bricks and other material likely to produce stoppage, a central low-point blow-off chamber, and clean-out tees. Inlet arrangements automatically send all average or lesser flows through the 18-inch syphon only. The location of capped Cast Iron tees at 400 ft. intervals on both syphons had been a departure in clean-out and syphon entry procedure. The syphon cost $33,960 complete.

At Annapolis, Md.

From Left: (1) *Frank Roe (Carborundum Co.) and Chris Bingham, Supt. Filtration, Richmond, Va.* (2) *E. F. Donaldson, Supt. Filtration, and T. H. Stinchcomb, Supt. Distribution, Annapolis Md.* (3) *H. E. Beckwith and Others on Launch Trip to Navy Testing Station.* (4) *Coblentz (State Dept. Health); Pitkin (Oliver Filters); Clements (W. & T. Co.);* (5) *Jack Diven (Leadite Co.); Abel Wohlman (P. W. A. Engineer, Maryland and Delaware); Alan Darby (Dorr Co.)*

A. W. W. A. WATER TREATMENT TOPICS

A Digest of Papers Presented Before the Water Purification Division of A. W. W. A.

ELSEWHERE in this issue there appears a report covering papers and discussion presented before the Management and Operating Division of the American Water Works Association. Included therein is a digest of two papers, with discussion, comprising a symposium on corrosion of pipes by the soft Catskill supply of New York City, in which Dr. Hale presents a means of correction by excess lime application, productive of pH values of 10 or higher.

The following constitutes a report covering papers and committee reports presented before the Water Purification Division of the Association.

Tests and Specifications for Activated Carbons

One of the most absorbing topics discussed was that pertaining to laboratory tests for evaluating activated carbons used for taste and odor removal and the drafting of specifications prescribing standards to be met by carbon manufacturers.

Report of the Committee on Tests and Specifications for Chemicals Used in Water Treatment, presented by Chairman, M. M. Braidech, Senior Chemist, Baldwin Filters, Cleveland, O.

Mr. Braidech explained that the committee work of the past year had been largely confined to activated carbon because of the importance of this material and because of prevailing differences of opinions regarding methods of rating carbons. The number of chemicals now covered by the committee had been reduced to 22 and these were to be covered by as many separate monographs.

The special sub-committee on activated carbon had found information difficult to obtain; had worked with ten different brands of carbon, and from these efforts the context of the report had been drawn. It was apparent from results that water purification carbons had been markedly improved by manufacturers during the past three years. Mr. Braidech said that the more important conclusions were: That, the phenol-absorption test applied to carbons gave but an indirect index of taste and odor removal capacities. Further, the iodine and phenol values did not always harmonize. The Fox-Gage test appeared, on practical grounds, to be preferable to the Baylis-Gibbs test in determining residual phenol in the absorption tests. The too exacting technique and control, and the unreliability of reagent were the charges against the latter. It had been found best, on the whole, to employ distilled water in preparation of test suspensions and one hour of stirring was recommended in making the absorption tests. The phenol determination should be made on the test water only *after* removal of the carbon, if full values and check results were to be gotten. It was the recommendation of the committee that the "bonus and penalty" system [for deviation of manufacturers from the standard specifications] be made use of by large buyers.

S. T. Powell, Chemical Engineer, Baltimore, Md. Retiring Division Chairman

A. E. Berry, Chief Engineer Ontario Dept. of Health. New Division Chairman

Chas. R. Cox, Albany, N. Y. Secy. of the Division

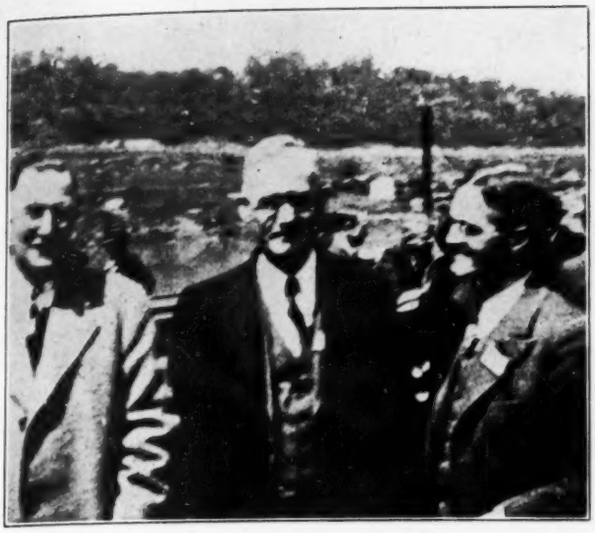
L. F. Warrick, State Sanitary Engineer, Madison, Wisconsin

JOHN R. BAYLIS, as the result of his recent work, which had revealed a considerable discrepancy between his ratings of certain carbons and those reported by the committee, questioned some of the latter's reported values. Based on considerable study, he continued to consider the phenol absorption test a dependable index of odor and taste absorption values and the best yet devised—particularly so for powdered carbons. He did not agree with the recommendations respecting moisture limits (8 per cent) and believed 140 deg. C. a preferable drying temperature to the 120 degrees recommended. He doubted that the relationship between carbon density and performance had been proven, and thought the design of stirrer used in making absorption and suspension tests should be specified. Mr. Baylis recommended the use of a plug of absorbent cotton for filtering our suspended carbon. Such was preferred in his laboratory to paper filtration. He questioned the fairness of the recommendation penalizing a manufacturer failing to meet a specification by a 3 per cent margin.

MR. BRAIDECH explained that the 8 per cent moisture limit had been selected because it was the average figure reported. The 120 degree drying temperature was selected because it was that commonly used in water laboratories. He stressed the point that the carbon absorption tests were empirical and the procedure recommended had to be rigidly adhered to in all details if consistent results or check results by two observers were to be had.

E. L. LUACES expressed the opinion that the Braidech committee knew more about evaluation of carbons for

"Birds of a Feather"



Norman, J. Howard (Toronto), John R. Baylis (Chicago) Wellington Donaldson (New York). What a Triumvirate of Water Treatment Brains!

water works than the more experienced European investigators. He hoped the report might be distributed to operators and manufacturers for comment and possible strengthening.

A. S. BEHRMAN said that there were three questions to be answered in connection with the committee work. Was the test method satisfactory and practicable? Was it representative and was it sufficiently accurate to justify a bonus penalty clause?

Mr. Braidech closed by asking members to send in their comments freely and every suggestion would be given due consideration by the committee.

The question of defraying expenses of the committee work and distribution of the report came up for discussion. Colonel Wrench, representing the manufacturers of "Nuchar", suggested that carbon manufacturers should bear the cost of the work, pro-rated on the basis of sales of each in the water field.

John Baylis suggested that A.W.W.A. establish a reference laboratory for testing activated carbons. The matter has been referred to the Committee on Water Works Practices.

Dissolved Oxygen Determination

The second progress report of the Joint Committee on Boiler Feed Water Studies was presented by C. H. FELLOWS,* Research Chemist, Detroit Edison Co. It dealt with the important *"Determination of Dissolved Oxygen"* in boiler water preparation and power station operation.

Mr. Fellows stated that 0.003 milliliter of oxygen per liter of water was frequently the limit of inaccuracy tolerated in boiler feed water control. The much favored Winkler method of water and sewage chemists had many weaknesses and its errors in boiler testing had been found due to sulphites, organic matter and also from iron, should more than 0.7 p.p.m. be present. The potassium iodide reagent had to be free of iodates and the indefiniteness of the starch endpoint required the use of *fresh* root-starch rather than a cereal starch. The weakness of the thiosulphate solution and necessity for cooling of the sample to less than 70 degrees C. to increase sensitivity of the starch were other important details. Also, a correction in boiler water control work had to be made for the dissolved oxygen in the reagents added. Only in connection with testing distilled water had the Winkler method proved sufficiently accurate to consider it dependable in boiler water control. On the whole the method was lacking in many respects.

DR. F. E. HALE defended the Winkler method, if properly manipulated and reagents properly prepared and preserved. He considered hydrochloric acid preferable, however, to the sulphuric acid specified in the standard procedure. Mr. Fellows' reply was to the effect that Dr. Hale was competent to judge as a water works chemist but he doubted that his experience was of an order to render opinions on the utility or dependability of the Winkler method in power station work. He hardly believed that the opinions of 10 power station chemists could be ignored just because the Winkler method was sufficiently satisfactory for general water and stream pollution work. To this, the chairman, S. T. Powell, added a word of warning and agreed that the Winkler method lacked demanded accuracy in the highly important problem of holding dissolved oxygen to a minimum (preferably zero) in the power station work.

"A Simplified Colorimetric Method for Dissolved Oxygen Determinations"—By F. W. GILCREAS, Chemist, State Department of Health, Albany, N. Y.

Mr. Gilcreas reported on a new method for determining D.O. which had proved sufficiently accurate for most laboratories and especially valuable as a field method. It possessed far greater simplicity than the present standard (Winkler) method which required several reagents and much manipulation and a titration involving the none too certain starch-iodide endpoint.

Mr. Gilcreas explained that the method had been first suggested by Dr. Isaacs of Columbia University and thereafter modified, with certain improvements, in his (Gilcreas) laboratory. It consisted of adding to a 2 oz. water sample approximately 0.13 grams of "Amidol" (di-aminophenol hydrochloride) after first adding approximately the same quantity (0.13 grams) of sodium citrate, in solution to buffer the sample. In the original procedure 'amidol" tablets were used but it had proved preferable to have the "amidol" powder put up in No. 2 druggist's capsules which will hold sufficiently close to the 0.13 grams for all requirements, if packed full.

The quality and rate of color development depended upon the pH value of the sample. Since a pH of ap-

*Mr. Fellows was later elected to chairmanship of the Joint Committee on Boiler Feed Water Studies to take over the work of Sheppard T. Powell who asked to be relieved after several years of valued direction of this very productive committee.—Editor.

M. M. Braidech (Cleveland) Learned a Lot About Ammoniation. Now Is Getting the "Low-Down" on All Water Purification Chemicals—Especially Activated Carbons. Paul Weir (Atlanta) Gets Some of the "Low-Down" at First Hand—That's What Conventions Are Good For

Frank Green (Little Falls, N. J.) Says "Anthrafilt" Looks Good to Him as a Filter Media. J. W. McAmis (Greeneville, Tenn.), the Pioneer "Ammoniator" in America, Finds Ferric Iron a Money Saving Modern Coagulant. Bill Lovejoy (Louisville, Ky.) Reports That "Flocculators," Like Wide Awake Operators, Pay Their Way and More

proximately 5.0 seemed most effective the addition of the citrate of soda ahead of the "amidol" was important. The red color would develop to full intensity within 30 minutes and would remain undiminished for two hours. The samples in 2 oz. square sided glass stoppered bottles were compared horizontally with permanent standards in similar bottles. The accuracy of the method had proved sufficient for ordinary water and sewage testing —0.5 p.p.m. max. error with 8 p.p.m. dissolved oxygen and 0.1 p.p.m. max. at 2 p.p.m. concentration—i.e., roughly 5 per cent low.

The method had proved reliable in the presence of the following interfering substances—available chlorine, 1.5 p.p.m.; ferric iron, 0.5 p.p.m.; ferrous iron, 3 p.p.m.; nitrites, 2 p.p.m.; sulphites, 5 p.p.m.; hydrogen sulphide 5 p.p.m.; and normal carbonate alkalinity up to 50 parts. The method had not proved satisfactory for seawater but was so for sewage and effluents.

In reply to questions, Mr. Gilcreas stated that manganese had not interfered in concentrations so far met with, but the limit of tolerance would doubtless be somewhat below those given for ferric iron.

GEORGE NORCOM, who had "once lost the seat out of his pants" when the concentrated sulphuric acid Winkler method reagent (just one of several) got turned over, said that he was happy to learn of a simplified vest-pocket method for D.O. determinations in the field. As an engineer he was doubly grateful for the simplified technic.

Anthracite as Filtering Material

The tendency today is decidedly toward higher expansions of filter beds in attempts to increase the efficiency of bed cleansing and economy of wash water used. This being so, interest in a material of lower gravity than silica sand, which makes possible its flotation with less upward velocity and volume of wash water; and, therefore, the best use of limited wash water facilities, was manifest in the following paper dealing with the preparation and qualities of crushed and graded anthracite for rapid filtration.

"The Preparation of Fine Anthracite for Use in Filtration Plants"—By E. L. BULLER, Research Engineer, Hudson Coal Company, Scranton, Pa.

The author described the special method used in preparing and grading crushed anthracite coal for use as a filtering material. Especial attention had been paid to removal of the fine material and by hydraulic classification it had been possible to produce a product of practically 100 per cent consistency so far as specific gravity and purity (carbon and ash content) was concerned. The product was as nearly pure high grade anthracite as was possible to make it. Uniformity of run, careful control of effective size and uniformity coefficient resulted likewise from the hydraulic screen shaker separations. The material had been shipped to several plants which were watching the comparative results with other filter materials. The presentation was illustrated with pictures, diagrams and graphs.

H. G. TURNER, Director of Research, The Anthracite Institute, State College, Pa., stated that Mr. Buller and the Hudson Coal Company deserved considerable credit for the development of methods which insured a product both clean, uniform and dependable. Anthracite had been used for many years as a filter media but a reliable source of dependable and economical supply had been lacking and therefore until now its consideration had not been justified on practical grounds.

FRANK W. GREEN, Supt. of Filtration, Little Falls, N. J., reported on his experiences with "Anthrafilt," produced by the Hudson Coal Company, in a filter operated at 200 m.g. per acre day. He said the anthracite weighed but 55 pounds per cubic foot and the bed had been kept in good condition with a wash rise one-third that required to properly cleanse a sand bed. With lime added to the raw water the filter had effectively removed manganese and 1,500 units of algae. He believed that the anthracite had some value also in improving the taste and odor of the water. Asked if mud balls had appeared in the "Anthrafilt" bed Mr. Green replied that they had not but that the supply was not of a highly turbid nature.

A. S. BEHRMAN, International Filter Company, called attention to experiences wherein, with hot process of water softening, silica sand was partly dissolved by the hot alkali and constituted a great objection in boiler water production. Anthracite being almost pure carbon was attacked mildly if at all and was therefore superior in such cases. Its lower gravity was a definitely decided asset in many situations.

JOHN R. BAYLIS called attention of the greater porosity of a filter bed of angular material, such as anthracite, than was true of rounded sea sand—(51 as against 44 for sand)—and this quality accounted for longer filter runs with anthracite. There was danger of mud balls working to the bottom of anthracite beds more so than sand beds, should mud balls be formed. Mr. Baylis was, however, basing his prediction on the known gravity of mud-balls formed in sand filters, rather than on evidence gained from observation of anthracite beds in use.

Dr. Hale warned that with prechlorination there was a possibility of chlorphenol taste production when using anthracite. Mr. Green's experience with "Anthrafilt" involved prechlorination, and he reported that no such development had occurred.

Mr. Powell pointed out the possible desirability of "conditioning" anthracite with a hot caustic treatment prior to its use in boiler feed water treatment. Thereby the removal of traces of silica that might be dissolved from the anthracite during its initial usage would be insured.

Algal Activities

"Results of Algae Activity, Some Familiar, Other Obscure"—By W. C. PURDY, U.S.P.H. Service, Washington, D. C.

Mr. Purdy called attention to the great natural input of oxygen into polluted streams which many times exceeded the atmospheric aeration effect of wave action, ripples or rapids. He pointed out the value of such phenomena in natural stream purification. The fact was, that oxygen produced by the algae was so finely divided and possessed such marked solution pressure (5 times that of atmospheric oxygen which as air is mixed with 80 per cent nitrogen) as to be many times more effective than oxygen solution through natural aeration. In stream pollution studies weight and recognition should be accorded the factor of reoxygenation

by algae. Experiments on closed carboys of sewage polluted water compared with clean water had indicated the amazing oxygenation from the green algae in concentration just sufficient to tint the waters in the carboys.

Mr. Purdy directed attention to the poisons which surrounded blue-green algae growth. Domestic animals drinking algae infested waters had died. And, he thought perhaps outbreaks of intestinal upsets of residents on the Elk and Ohio Rivers during the serious drought periods may have been due to toxins produced by algae in the sluggish streams in the affected areas.

(Such a brief digest fails utterly to give an adequate indication of the value of Mr. Purdy's paper which justifies printing in full in a future issue.—Editor.)

A. E. BERRY, Chief Engineer, Ontario Department of Health, Toronto, reported that anabena in heavy growth in Ontario waters had killed 20 cattle and paralyzed ducks in two minutes. As to oxidizing effects, he had observed a case wherein algae laden water had given a positive test indicating 0.3 p.p.m. chlorine.* After filtration (in which 40 hr. runs were cut to 2 hrs.) there was no indication of a false color in the effluent.

"Limiting Standards of Quality Applicable to Sources of Water Supplies"—By H. W. STREETER, Sanitary Engineer, U.S.P.H.S., Cincinnati, O.

Mr. Streeter reported on his extended studies to determine the limitation of pollution of sources of water supply which could be dependably coped with by modern methods of water purification. Conclusions reached had been based on studies of plant loadings and plant performance in the Ohio River basin (17 plants) and also on the Great Lakes (14 plants). In addition, the performance of the carefully controlled Public Health Service experimental plant at Cincinnati had been used in his evaluations.

To produce a filter plant effluent to meet U. S. Treasury Standards (not more than 1 b. coli per 100 c.c.) it appeared that the coli index (organism per 100 c.c.) in the raw waters should not exceed 4,000 for the Great Lakes water nor 6,000 for the Ohio River and tributaries. He had found that the second requirement of the Treasury Department Standards really governed in fixing safe limits and the index on raw waters from Great Lakes should not exceed 1,000 and the river supply only 3,000. In the case of ground waters safeguarded by chlorination alone, the limiting index was only 50 (average) with flare-ups to 400 allowable not more than 5 per cent of the time.

Mr. Streeter commented that plants employing prechlorination could apparently meet the standard for effluents when loaded with a raw water having a coli index of 20,000 but that other things than living bacteria had to be considered in production of potable water and such high loadings indicated pollution in excess of that which was justifiably acceptable in a source of domestic supply. On this score the standards limiting polluting material in raw waters should control, in determining cleanliness and acceptability of supply, rather than strict adherence to the b. coli index of the water leaving the treatment plant. For supplies polluted by industrial wastes there was need for chemical standards in addition to biological standards.

H. E. JORDAN, President of the Association, in complimenting the author, said that his presentation may become a milestone in the fight by the Association for purer sources of water supply and argued for the desirability of increasingly stringent standards of the Treasury Department to place more weight on limiting the pollution reaching the plant intakes in this country and, therefore, greater assurance of a cleaner product and more dependable purification plant performance. He believed that Streeter's contributions should be given recognition in a National Planning and Stream Conservation Program for the immediate future.

*Note: The same condition has been observed elsewhere and sometimes it has been assumed, erroneously, that the false color was due to manganese in the unchlorinated raw water supply. It seems that this effect provides circumstantial evidence which suggests that the oxygen evolved on the surfaces of green algae is of the nature of socalled noscent oxygen such as is produced when ozone or hydrogen peroxide breaks down in the presence of organic matter. All of this checks with Mr. Purdy's claims as to the marked efficacy of algae generated oxygen in purification.—Editor.

Charles H. Burdick, Supt. Filtration, Flint, Mich. R. F. Goudey, Engineer in Charge Water Quality, Los Angeles, Calif. (Convention Host in 1936.) M. F. Trice, Principal Assistant Engineer State Dept. Health, Raleigh, N. C., Is a Live Wire. Director of the Assocation

L. F. WARRICK, State Sanitary Engineer of Wisconsin, said that stream cleansing would with certainty follow the establishment of proposed Treasury Department Standards limiting coli index of water supplies prior to treatment. If placed in force it would aid state and local authorities in procuring pollution abatement, now slow in materializing because of the current belief that modern purification practices were more dependable than actually appeared to be the case.

Zeolite Testing and Specifications

In reporting for the Committee on Testing Zeolites—C. P. HOOVER as chairman said that the report would be turned in without reading because of lack of time. Copies could be had upon request to committee members or himself as chairman. In hastily reviewing its context, he said that the report dealt principally with tests and properties to be specified by the buyer of zeolites. So far it had been possible to definitely specify grain size, percentage of fines, weight per cubic foot and exchange capacities. A specification as to effective life had not been possible of definition. The most satisfactory tests to determine the expected life had not been decided upon because these were still in the course of being perfected.

A. S. BEHRMAN commented that the methods outlined by the Hoover committee represented a considerable improvement over those previously suggested and both he and Mr. Applebaum offered assistance and active support of its work.

With Apologies

Lack of space makes it necessary to cut this report short with a listing of additional papers which were presented before the Water Purification Division:

(a) "Determining the Bacteriological Quality of Drinking Water"—By C. T. Butterfield and J. K. Hoskins, U.S.P.H. Service, Cincinnati, O.

(b) "Report on Studies of Various Selective Media for Coli Aerogenes Isolation"—By John F. Norton, The Upjohn Co., Kalamazoo, Mich., and C. C. Ruchroft, Sanitary District of Chicago, Chicago, Ill.

(c) "The Relative Growth of Recently Isolated and Stock Strains of b. coli and b. Aerogenes in Various Culture Media, as Measured by the Butterfield, Hoskins Method"—By R. E. Noble, Prin. Bacteriologist, Board of Health, Chicago, Ill.

CALIFORNIA SEWAGE WORKS ASSOCIATION

Holds 7th Spring Conference at Fresno

THE 7th Spring Conference of the California Sewage Works Association was held at Fresno, Calif., on April 26th and 27th, with an attendance of between 80 and 90. The forenoon of the first day was devoted to an inspection trip to the treatment works of Lemoore and Fresno.

A brief adjournment, called by President Haseltine, memorialized the loss to the Association of O. E. Steward, former City Engineer of Anaheim, Calif., who had come to an untimely death in an automobile accident.

At this conference chemical treatment and chlorination of sewages were the topics featured.

Technical Sessions

(President T. R. Haseltine presiding.)

Scheduled to be presented by A. K. WARREN, Chief Engineer, Los Angeles Sanitation Districts, was a report on **"The Status of the Activated Sludge Patent Situation."** The author being unable to attend, this subject was covered by A. M. Rawn, Assistant Chief Engineer of the Los Angeles Sanitation Districts, who explained that the report could not be presented in completed form because of certain pending negotiations with Activated Sludge, Inc., and therefore his remarks must be construed as an informal progress report. The Committee had been set up to look after the interests of California municipalities now using the activated sludge process. However, San Francisco, Laguna Beach and others had made satisfactory and advantageous settlements with the Activated Sludge, Inc., who now hold patents covering the process.

Mr. Rawn pointed to the heavy cost to Milwaukee and Chicago and the great amount of time consumed in fighting suits brought by the patent holders. Based on the Committee's study it appeared best to make settlement out of court if such could be done at a fair and reasonable cost to the city. The move started by the Committee had not been without profit to California municipalities, however, because it had served as a central source of information (collection and distribution) and thus had been instrumental in securing more reasonable settlements with Activated Sludge, Inc. Following Mr. Rawn, a member said that he hoped this service to the Association would be brought to the attention of officials of California municipalities.

"The Newer Applications of Chlorine in Sewage Treatment"—A. C. BEYER, Sanitary Engineer, Wallace and Tiernan Company, San Francisco, Calif.

Mr. Beyer reviewed the established uses of chlorine in sewage treatment. The more important were the control of odors and protection of sewers from disintegration by partial chlorination to check hydrogen sulphide production; by the same process the preservation of freshness of sewage had thereby improved plant operating conditions and had resulted in raising the capacity of certain processes; B.O.D. reduction of effluents and stream improvements; and, relief from fly breeding and ponding on trickling filters had been also well established. He also referred to the uses of chlorine for similar purposes in treatment of organic trade wastes. Of special interest at activated sludge plants was the scheme of sludge thickening which involved moderate chlorination of the upper water strata in the surplus sludge clarifier and thickener. While concentrating, the sludge was preserved against bacterial degradation (bulking) by the partial chlorination. The reduced volume of sludge thus resulting had minimized supernatant liquor problems and gave less disturbance in the digesters. The clarifier effluent (top water) contained residual chlorine and was valued for its disinfecting properties. The sludge, however, contained none.

Mr. Beyer called attention to recent disclosures by Rudolfs and associates, in New Jersey, which had revealed the marked effect of partial chlorination on b. coli and general bacterial reduction—provided that mixing was rapid and efficient, the period of contact sufficient, and the sewage fairly fresh at point of application. This observation emphasized the merits of partial and early chlorination of sewage for odor control, its disinfection and preservation of freshness by application as far up sewers as was practicable.

With the trends toward chemical treatment of sewage, chlorine for producing chlorinated copperas (Birmingham, Ala., Plainfield, N. J., etc.) or producing ferric chloride by chlorinating scrap iron (Scott-Darcey Process at Oklahoma City and elsewhere) represented an indirect but important use of chlorine in sewage treatment. Important to the success of chemical precipitation was the freshness of sewage and absence of reducing compounds, both of which prechlorination insured. In odor control and prevention of sewer attack by hydrogen sulphide it was not necessary to carry the Scott-Darcey process of producing ferric chloride to completion, but stop rather at the half way point—i.e., save chlorine by producing only ferrous chloride. The expense of odor control with chlorine converted to ferrous chloride was less than that of direct chlorination because the iron chloride was not depreciated by chlorine demanding matter other than the sulphides and all of the chlorine added in the form of ferrous chloride became thus indirectly "available" in the cycle of chlorine to iron chloride to iron sulphide. The latter being promptly formed by combination with all of the sulphide present caused the volatile sulphide to be fixed in the form of a non-volatile product, sulphide of iron. In any excess ferrous chloride added, the iron would remain "available" for "fixing" additional sulphides as rapidly as generated or contributed further down the trunk sewer. This property made the chlorinated iron scheme economical and practical of application at any convenient point on the sewer—be it above or below the point of sulphide appearance.

For chemical precipitation or sludge dewatering the ferrous chloride was not sufficient and the completion of the Scott-Darcey process to produce ferric chloride, involving 33 per cent additional chlorine, was essential. At Oklahoma City the use of a ferrous chloride tower (chlorine water rising through a tower filled with scrap iron) had been very successful on a long and troublesome sewer carrying packing house wastes. At the two treatment plants Scott-Darcey ferric chloride generators were in use for chemical precipitation. In the latter the chlorine consumption had been 60 to 70 lbs. per million gals. and lime 300 to 400 lbs. per m.g. of sewage treated.

Mr. Beyer announced that his company had recently developed a large vacuum type chlorinator of 2,000 lbs. per day capacity, which would simplify the problem of large scale sewage chlorination, either direct or

through the production of the chlorides of iron or chlorinated copperas.

"The Probable Field of Chemical Treatment of Sewage"—R. F. Goudey, Sanitary Engineer, Water Department, Los Angeles, Calif.

Mr. Goudey, in an interesting and comprehensive paper encouraged engineers to take a critical and analytical attitude when evaluating proprietary processes of chemical treatment of sewage. The activated sludge situation and also the activity of equipment and chemical producers had contributed to a decided trend toward chemical precipitation processes. He felt that engineers were more inclined to favor a combination of chemical with biological treatment than to consider chemical methods alone as the panacea of all evils of sewage treatment. He expressed a fear that engineers might soon be even more severely harassed by chemical treatment patents than they had been with activated sludge patents. He was of the opinion that much of the published data on chemical treatment was misleading.

Mr. Goudey listed five aspects of chemical treatment, including simple precipitation in a single tank; two stage sedimentation with return of all secondary (chemical) sludge to the crude sewage; and, combinations of chemical precipitation with biological treatment. Chemical conditioning of sludges had passed the experimental stage and its use was assured with a trend toward elimination of sludge digestion.

Mr. Goudey reviewed the work done at Los Angeles in improving the activated sludge process wherein lime was fed to the crude sewage to boost its pH when below 6.5. Chlorine and copper sulphate had been added to the sludge reaeration tanks to hold bacterial multiplication and other undesirable organisms in check, 1 million bacteria per c.c. being the limit allowed. Ferric chloride was used in sludge dewatering. The average chemical cost for these beneficial effects to the process had been only $1.50 per million gallons. On the Pacific Coast the greater cost of chemicals, and the cheaper power rates than existed in the East, would work in favor of the activated sludge process alone or assisted by chemicals and work against purely chemical processes where continuous use was to be involved. The net cost of chemical treatment might be evaluated in two ways. One had to consider whether the expense of part time use had been spread over the volume of sewage treated during the entire year or charged against that actually chemically treated.

Mr. Goudey did not believe that anything short of a double stage coagulation, with the first a low pH and the second at high pH, that chemical precipitation could effectively remove most of the colloids. He did think that a combination of activated sludge and chemical treatment would insure a stabilized effluent and a dependable process not subject to the vagaries of either taken singly. He outlined a suggested scheme involving primary sedimentation followed by a split of the flow between activated sludge and chemical precipitation units. The chemical sludge was to be returned to the crude sewage. The surplus activated sludge was to be thickened, with the aid of chlorination of the top water. The primary tank sludge (chemical + crude) would be mixed with the thickened activated sludge and the combination dewatered. In the activated sludge reaeration-tank, lime, a ferric salt and copper sulphate would be used to control pH and excessive bacterial growth. Mr. Goudey predicted that with California prices the total cost of chemical for treatment and sludge conditioning would be roughly $9.00 per m.g. giving a flexible dependable combination process.

B. P. Phelps, Sanitary Engineer, San Diego, Calif., said that it was probable that some claims for chemical sewage treatment had been and would be exaggerated but that the analytical minds of professional engineers should be capable of evaluating and selecting the valuable features of chemical treatment processes. He did not agree with Mr. Goudey that power costs were uniformly low on the Pacific Coast and each case should be decided on prevailing costs and comparison. Chemical treatment possessed flexibility and the chemical plant was simple to design and could be made use of in many ways and was adapted to later changes or improvements whereas a biological plant could not be economically converted into a chemical plant. At San Diego an experimental plant had yielded results which warranted building a chemical type treatment plant, involving primary sedimentation, coagulation, secondary settling and effluent filtration, or straining. Ferric chloride and chlorine were to be used and the secondary sludge was to be returned to the crude sewage.

Ralph L. Stevenson said that it was not necessary to consider chemical treatment as other than a high grade intermediate treatment. As to the patent situation, he felt that patent protection was essential but that engineers and city authorities would likely find the license fee less burdensome than that being collected by Activated Sludge, Inc. He differed with Mr. Goudey on the matter of chemical cost for he had Eastern quotations only recently and these were not greatly different from West Coast prices. Mr. Stevenson named three California cities which are to install chemical treatment. San Francisco (sewage from one section of the city), San Luis Obispo and San Diego.

E. A. Reinke, Prin. Asst. Engr., California Department of Health, in commenting on the comparative cost of activated sludge and chemical treatment, reported that studies made by Black and Veatch (Kansas City Engineers), had caused them to recommend chemical treatment as the less costly of the two for the proposed treatment plant for Denver, Colo.

R. F. Goudey closed by saying that automatic control of chemical feeding devices to keep step with varying flows was practically an essential in chemical treatment practices. The other variable to contend with—the changing quality of the sewage from hour to hour—would be sufficient.

"A New Venturi Type Metering Device for Sewers"—H. J. Palmer and F. D. Bowlus, Engrs., Los Angeles County Sanitation District.

Feeling that there existed a need for a flow measuring device which would not possess the short comings of the existing available devices, the authors set about to make a study and attempt to develop something which would prove adaptable for installation in existing lines. The Parshal Venturi Flume was the nearest device to that desired; was satisfactory for large flows, but failed to answer for smaller lines.

Their studies had resulted in the design and installation of a variation (modification) of the Venturi flumes, requiring but one point of measurement. The ideal requirements such as low head loss, no reduction in sewer capacity, freedom from causing solids to be deposited and ease of installation had all been met in the new design.

The authors were highly complimented on this development which was without question an outstanding contribution to the profession.

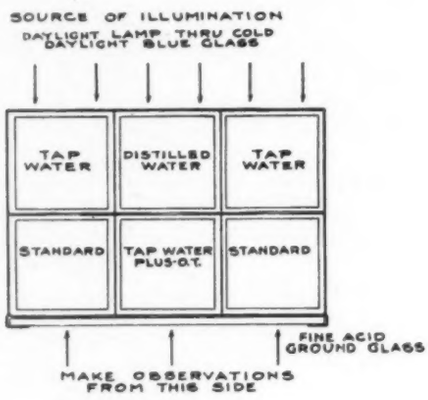
Acknowledgment.—The above report has been drawn from a more comprehensive one supplied by A. C. Beyer of San Francisco whose paper is included in this digest.

THE CHICAGO METHOD OF MAKING CHLORINE RESIDUAL DETERMINATIONS

By T. F. DONAHUE, JR.,[1] and EDWARD ZIMBON, SR.[2]
Chicago, Illinois

IN the determination of residual chlorine content of samples of water at the Chicago pumping stations a modification of the ortho-tolidine test is employed.

Experiments conducted in 1928 by H. H. Gerstein, San. Engr., Dept. Public Works, indicated that marked improvement in accuracy of the determination could be obtained by the use of inexpensive Whitall-Tatum 2 ounce (jar type) square bottles to advantage over Nessler tubes for holding the color standards. Comparisons were made by viewing the bottles from the side and turbidity was compensated for by placing water blanks behind the standards similar to the procedure followed in using the Enslow Comparator (See Fig. 1).



·FIGURE· 1·

Fig. 1—Arrangements of Samples and Standards to Compensate for Turbidity of Color

The Equipment

Matching of color standards with the color developed in the water sample is facilitated by use of a metal box with compartments for six bottles arranged as shown in Figure 1. Openings in the box permits light to pass through the three pairs of bottles to project the colors as images on an acid ground glass inserted in front of the box (See Fig. 2).

The main requisite for the accurate reading of the residuals is a white light—simulating north daylight as nearly as possible—passing through the three sets of bottles with equal intensity. To obtain properly diffused white light a lamp was designed using a Westinghouse 75 Watt inside frosted Daylight (blue) bulb as a source of light. The interior of the lighting compartment [including the upper and lower reflectors] is painted with a white flat paint containing enough blue pigment to counteract the yellowing effect of age. The light is reflected through a double strength opal flashed on blue cold-daylight glass before which the comparator box is placed.

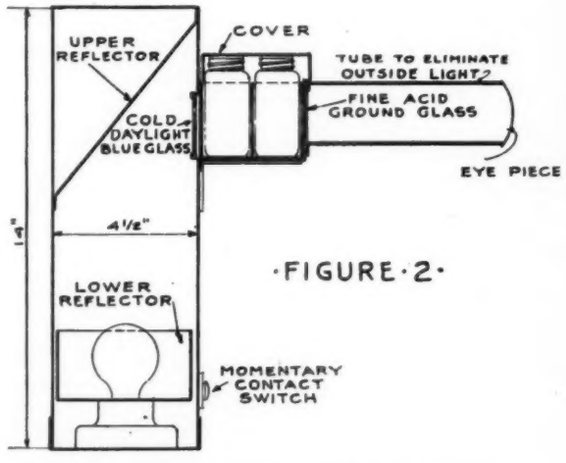
Despite air vents there appeared a rapid accumulation of a black smudge on the upper reflector, which interfered with accuracy of readings. To overcome this a momentary switch (Edwards No. 84 for 110-220 volt circuits) now shut off the light when the operator releases his finger from the contact button.

To eliminate the very serious effect of outside light, the container holding the sample and standards is covered and is equipped with an adjustable observation tube and eye pieces. All outside surfaces are painted a dull black to prevent reflection and glare.

New Standards Required

Immediately following the adoption of the new comparator and the 2 ounce square bottles the residual chlorine content of the treated water showed an apparent increase. Where a 3 pound per million gallons residual (0.36 p.p.m.) was to be expected, the test showed between 4.0 and 5.0 pounds. In many cases the residual recorded actually exceeded the dosage. The standards, compounded in accord with A.P.H.A. standard methods for use in 100 cc. Nessler tubes viewed from above, when used in the square bottles of 32 millimeter width and viewed from the side were 40 per cent too low.

To correct the standard for the 32 millimeter depth of solution the following procedure was used: Lake water of zero turbidity was treated with concentrated chlorine in a large flask. It was corrected by gradual dilution with more lake water until a sample treated with 1 cubic centimeter of ortho-tolidine in a Nessler tube, in which the 100 c.c. mark was 240 millimeters high, exactly checked the 5.0 pound per million gallons standard when viewed from above. The standardized 5.0 pound per million gallons water sample was poured into the 2 ounce square bottles, and a standard was then compounded which matched it exactly when viewed from the side. This process was repeated until proportions of copper sulfate and potassium dichromate solution had been determined for each concentration of chlorine.



·FIGURE·2·

Fig. 2—Comparator Developed at Chicago for Residual Chlorine Tests. Used in Routine Control of Chlorine Feed

[1]Sanitary Engineer, Dept. Public Works, Chicago.
[2]Chemist, Board of Health, Chicago.

Revised Standards for 32 Millimeter Depth of solution:

1. REAGENTS

(a) *Copper Sulfate Solution.*—Dissolve 15 grams of copper sulfate and 10 cubic centimeters of concentrated sulfuric acid in distilled water and make up to 1 liter.

(b) *Potassium Dichromate Solution.*—Dissolve 2.5 grams of potassium dichromate and 10 cubic centimeters of concentrated sulfuric acid in distilled water and make up to 1 liter.

2. STANDARDS

Mix the volume of each of these solutions as specified in the following table and make up to 100 c.c. with distilled water.

Chlorine Values		Potassium	
Pounds per Million Gallons	Parts per Million	Copper Sulfate Solution, cc.	Dichromate Solution, cc.
0.5	.06	7	0.8
1.0	.12	7	1.5
2.0	.24	8	3.6
3.0	.36	12	5.5
4.0	.48	20	7.4
5.0	.60	20	8.8

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Water Works, Sewerage and the PWA

Water Supply

From PWA funds there are being built or improved 1,087 water systems involving an expenditure of $111,500,000.

Local communities, aided by PWA loans and grants of $83,813,000, are spending $110,000,000. They are supplying the difference between the amount allotted by PWA for their projects and the total cost. Many allotments were grants only.

Complete new water systems are being installed in 744 communities at an estimated cost of $72,000,000, of which PWA loans and grants amount to $57,591,000. Departments of the Federal Government are building 99 projects on government property at a cost of $1,500,000.

Filtration plants to safeguard public health are being built in 37 communities at a cost of nearly $8,000,000. Existing water mains are being extended or replaced with 123 allotments totalling $10,169,000, and 84 reservoirs or elevated tanks are being built at a cost of $11,000,000 to increase storage capacity or give added pressure for fire protection.

More than 300 of the local projects have been completed and now are in use, and 350 are under construction and rapidly nearing completion.

Sewerage

Sewerage construction has been one of the most important phases of the PWA program—now amounting to better than $200,000,000 in new work.

Allotments were made for 622 projects, 58 of them being built by the Federal Government, and 564 being constructed by local communities with the aid of PWA loans and grants.

The sewerage construction program financed by PWA will be expanded under the new works program. One of the first allotments recommended to the President by the Advisory Committee on Allotments was a grant to aid New York City in completing its $25,000,000 Ward's Island disposal plant.

Approximately 250 sewer and sewage disposal plant projects financed by loans and grants from the old public works appropriations have been completed, and about the same number now are under construction. The completed jobs cost about $13,000,000 and the work under way will require expenditure of more than $140,000,000.

SOME OF THE LARGER PROJECTS

Chicago Sanitary District	$42,000,000
St. Paul-Minneapolis	16,000,000
Cleveland	9,000,000
Washington, D. C.	4,000,000
Arlington County, Va.	2,500,000
San Francisco	2,187,000
Milwaukee, Wis.	1,850,000

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Association Meetings Scheduled:

June 24-26—**Pennsylvania Sewage Works Association.** State College, Pa. Secy., L. D. Matter, State Department of Health, Wilkes-Barre, Pa.

June 26-28—**Pennsylvania Water Works Operators' Association.** State College, Pa. Sec'y., I. M. Glace, State Department of Health, Harrisburg, Pa.

June 27—**New England Water Works Association.** Spring Meeting and Boat Trip to Provincetown, Mass. Roger W. Esty, Supt., Water Works, Danvers, Mass., is in charge of arrangements.

July 3-5—**American Society Civil Engineers.** (Annual Convention) Sec'y., Geo. T. Seabury, 33 West 39th St., New York City.

Aug. 22-23—**Central States Section A. W. W. A.** (Annual Meeting.) Pittsburgh, Pa. Fort Pitt Hotel, Pittsburgh, Pa. Sec'y., H. Lloyd Nelson, U. S. Pipe and Foundry Co., Koppers Bldg., Pittsburgh, Pa.

Sept. 17-20—**New England Water Works Association.** 54th Annual Convention. Providence-Biltmore Hotel, Providence, R. I. Sec'y, F. J. Gifford, 613 Statler Bldg., Boston, Mass.

Oct. (3rd week)—**Pennsylvania Water Works Association.** (40th Annual Meeting.) Haddon Hall, Atlantic City, N. J. Sec'y., H. F. Snow, 507 Telegraph Bldg., Harrisburg, Pa.

Oct. 4-5—**North Dakota Water and Sewage Works Conference.** Grand Forks, N. D. Sec'y-Treas. M. D. Hollis, State San. Engr., Bismarck, N. D.

Oct. 7-10—**American Public Health Association.** (64th Annual Meeting.) Hotel Schroeder, Milwaukee, Wis. Ass't Sec'y, W. R. Walsh, % A. P. H. A. Rockefeller Center, New York City.

Oct. 14-17—**Southwest Section A. W. W. A.*** Houston, Texas. Sec'y, Lewis A. Quigley, Supt. Water Works, Fort Worth Texas. (* Former Southwest Water Works Ass'n.)

Oct. 14-15—**American Society Municipal Engineers and International Association Public Works Officials.** Netherland Plaza Hotel, Cincinnati, Ohio. Executive-Director, D. C. Stone, 850 East 58th St., Chicago, Ill.

Oct. 18-19—**Minnesota Section A. W. W. A.** St. Paul, Minn. Sec'y-Treas., R. M. Finch, % Wallace and Tiernan Co., 416 Flour Exchange Bldg., Minneapolis, Minn.

Oct. 23-26—**California Section A. W. W. A.** San Diego, Calif. Sec'y, J. E. Phillips, Department of Water and Power, Los Angeles, Calif.

Nov. 4-6.—**North Carolina Section A. W. W. A.** Durham, N. C. M. F. Trice, State Board of Health, Raleigh, N. C.

Nov. 7-8—**Virginia Section A. W. W. A.** Hotel Roanoke, Roanoke, Va. Sec'y, H. W. Snidow, State Department of Health, Richmond, Va.

Nov. 6-8—**Missouri Valley Section A. W. W. A.** Fort Des Moines, Ia. Sec'y-Treas. Earl L. Waterman, Prof. Sanitary Engineering, University of Iowa, Iowa City, Ia.

EDITORIAL

Raw Water Cleanliness Standards

HAROLD W. STREETER of the U. S. Public Health Service, on another page of this issue, has sent out a warning note to the effect that although it is possible to take into a water purification plant a fairly filthy water and by modern methods turn out a water which meets the stringent U. S. Treasury Department Standards of safety, in respect to its content of residual fecal organisms—Is the practice safe? Is it basically sound? Is it common sense to allow the continuing and growing pollution of our National waters by municipality and industry, just because we are capable as scientists of making it safe? Is not the idea of a standard of reasonable cleanliness of the raw product a common sense and a basically sound one? Mr. Streeter answers these questions by showing that our faith in modern methods and purification plants can be shaken by a careful study of day by day, or hour by hour, rather than month by month plant performance. He further answers these questions by showing that streams do become so polluted as to create intestinal disturbances in communities served with treated water therefrom, even though the product distributed had passed the modern tests for safety—namely, the U. S. Treasury Department Standard in respect to bacterial content.

One only has to study his findings to realize the soundness of the suggested policy of establishing and promoting standards of cleanliness for raw-waters, rather than to rely solely on treated water standards of safety and wholesomeness. The first met, the second automatically becomes assured with reasonable and economical purification procedures.

It is the belief of WATER WORKS AND SEWERAGE that there is need for a central authority to establish and enforce "National Standards for Raw Water Cleanliness." That such standards should be made sufficiently broad to include limits on taste producing and toxic materials of industrial origin as well as b. coli index of pollution of fecal origin.

Water works authorities desire a clean water, regardless of how impressed they may be with their ability to cope with severe conditions. State authorities have been but partially successful in bettering stream conditions. To make their efforts more effective, Federal standards would bring about results in procuring raw water quality betterment (pollution abatement) that the U. S. Treasury Standards, placed in the hands of State authorities, did in procuring better purification facilities to meet the required effluent standards. The water works profession will be as grateful for such improvements as will the public that prefers its water "straight" rather than be expected, at times, to relish a chlorine cocktail, an algae highball, or a phenol phizz.

This story has an appeal to every hard-headed or shrewd business man—be he from Main Street or Wall Street. Then, too, there is a traditional relationship between women and Bargain Days.

In municipalities with existing water works and sewerage systems (some badly neglected in recent years), managers and operators have the opportunity to urge the authorities to take advantage of "Uncle Sam's Bargain Sale" for procuring miscellaneous improvements to be found at the counter marked "Accessories." Leakage Surveys and waste stoppage; general repairs and painting; service pressure deficiency relief measures; main cleaning and re-habilitation; improved treatment facilities; filter overhauling; effective valving of mains; fire hydrant surveys, additions and replacements—these are but a few of the gadgets to be found in the "Accessories Department" of Uncle Sam's newly established "Branch Stores." But, one must reach there before the "Sold Out" sign appears.

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Bargain Days

UNCLE SAM has hung out a sign which in effect says—BARGAIN DAYS FOR MUNICIPALITIES!!! No cash needed!! Enjoy the *benefits* of your purchases *while paying for them* at almost *half price!*

Up near the front of the shop is a counter labeled "Water Works and Accessories." On another, "Sewers and Sewage Treatment Plants." To make it easier for prospective customers to come to his big sale, Uncle Sam has taken the goods, and the sales force, out of the big down-town store in Washington and has established branch stores in every state. How long the sale will go on before the "Sold Out" sign goes up remains to be seen.

All of this is, of course, a picturization of the result of the Administration's decision to have the Federal Government through PWA practically match municipalities with dollar for dollar in order to encourage construction of new water works and sewerage facilities or provide improvements to existing works.

On May 24th the Administration announced that under the new PWA program the grant for public works was to be raised from the 30 per cent of the past to 45 per cent; and the new rate of interest was to be reduced to 3 per cent from the 4 per cent previously charged.

Under less alluring circumstances, projects under way or completed through PWA assistance to date amount to $111,500,000 on 1,087 water supply projects; $200,000,000 on 622 sewerage projects.

The new allowance of greater flexibility in management and the fixing of rates of pay for labor and, moreover, with supervision, governed within reason by local authorities to meet existing conditions, is especially encouraging. Further, the decentralization of PWA by establishing complete organizations in each State PWA Engineer's Office, in order to facilitate and simplify the process of procuring approvals of applications and the speeding up of the clearing of projects, and the prompt distribution of funds to municipalities, serves as a further decided encouragement to prospective applicants.

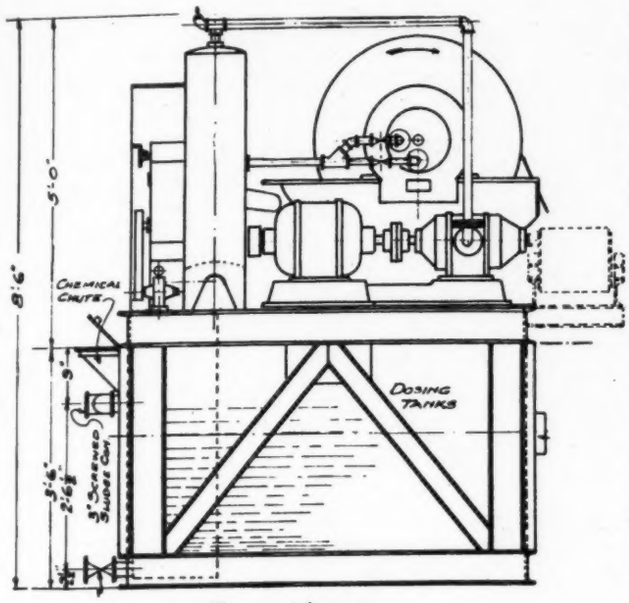
The analytically minded will quickly find that a loan of $55.00 plus the grant of $45.00, with 3 per cent interest on the loan only, is equivalent to procuring the $100 through normal channels at an interest charge of only 1.65 per cent. If it is assumed that the loan must be amortized over a period of 25 years, the yearly sinking fund requirement amounts to but $2.20 on the $55.00 borrowed—that is, only 2.2 per cent per year on the expended $100. The combined cost of 3.85 per cent covers interest charges plus amortization of the cost of the project—an extraordinarily low figure.

What could be more encouraging to the small community, needful of water works or a sewerage system, than the opportunity to obtain these permanent benefits at a cost of only 55 cents on the dollar and also be allowed to pay off the whole cost in 25 years, at less than $4 per year for each $100 cost of the project.

NEW EQUIPMENT AND LITERATURE

New Sludge Dewatering Unit for Small Plants

Oliver United Filters, Inc., announces the development of a much to be desired small sized sludge dewatering unit for communities of approximately 10,000 population. The purpose is to supply small as well as large cities with vacuum sludge filtering equipment of appropriate size and cost.



Oliver Sludge Dewatering Unit

The unit which comes complete and ready for installation is available in three sizes, 18, 36 and 54 sq. ft. Overall its height is less than 9 ft. and therefore so compact that it can be mounted on a truck to serve as a portable unit for two or more disposal plants. Each unit includes sludge mixing tanks (batch or continuous type) to effect the proper introduction of chemicals.

This new addition to Oliver Sludge Dewatering Units gives to the smaller communities the several advantages that larger cities now have with mechanical dewatering of sludge.

Further details can be obtained by addressing Oliver United Filters, Inc., 33 West 42nd Street, New York City, or their branch offices in Chicago and San Francisco.

New Type Pipe Coupling

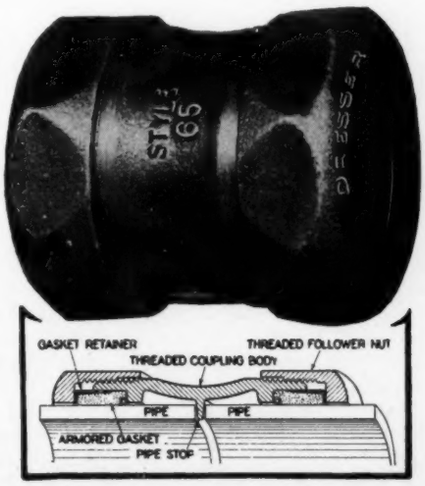
Several distinctive features are incorporated in a new, self-contained pipe coupling for small sizes of pipes, just announced by the S. R. Dresser Manufacturing Company of Bradford, Pa., and shown for the first time at the A. W. W. A. convention last month in Cincinnati.

To make a connection with the new *Dresser Style 65 Compression Coupling*, nothing is needed, except the pipe, the coupling and an ordinary wrench. Plain end pipe is used, no preparation of the pipe ends—such as threading, grooving, or flaring—being necessary. Making the joint simply involves inserting the pipe ends into the coupling (which comes assembled) and then a quick tightening of two threaded octagonal nuts with a wrench.

The Dresser Company assures the users that the resulting joint is permanently tight, absorbs vibration, expansion and contraction movements, and permits marked deflections of the pipe in the joint. Such flexibility, with permanent tightness, is the result of the presence of two resilient gaskets within the coupling that encircle the pipe ends — one gasket around each end. As the nuts are tightened, these gaskets are compressed tightly around the pipe, gripping it with marked force to give a positive seal. The principle involved is essentially the same as that used in Dresser Couplings for the past 50 years.

Other advantages claimed are these: The pipe need not be cut to exact lengths; joint making in cramped quarters is simplified; repairs on old lines can be quickly made. The joint is suitable for exposed lines because of its compact appearance.

These new couplings are supplied in standard steel pipe sizes from 3/8th to 2 inch I. D. inclusive, black or galvanized. They are recommended for all types of services. The gaskets, which are provided with flexible, metallic, patented armor in the tip, have been designed for temperatures up to 200 deg. F.



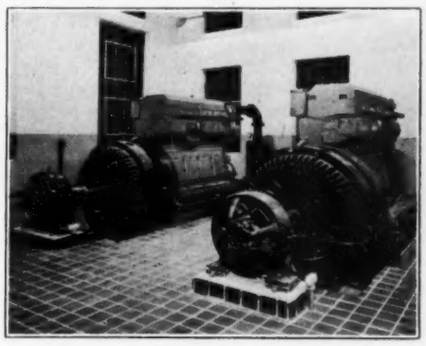
Dresser Compression Coupling

This novel utility coupling should find a wide variety of practical applications under all conditions of pressure—especially in the hard-to-get-to-places. Ells and Tees are also available. For descriptive circular illustrating a section through these newest of couplings and their applications, address the S. R. Dresser Manufacturing Company, Bradford, Pa.

Old Line Gas Engines for New Line Duty

Cooper-Bessemer Diesel and Gas Engines have for many years been considered outstanding in the oil and gas field, are well established in other industrial fields and also in the marine field.

Less well known in the water and sewage field Cooper-Bessemer Gas Engines have recently been introduced into the latter in a power generating installation (above illustrated) at the new sewage treatment works at Durham, N. C. Cooper-Bessemer Engines are especially adapted to continuous duty because of characteristic features of design, particularly their slow speed and method of carburetion. The twin installation at Durham is driving generators and producing from sludge digester gas more power than is required to operate the blowers and other equipment in the plant. The sewage plant sells its surplus power to the city's electric utility, something novel in sewage treatment practice.



Gas Engine-Generators; Durham's New Sewage Works (W. M. Piatt, Engr.)

Those desirous of making sewage treatment as nearly self-supporting as possible will find much of interest in a copy of "Cooper-Bessemer Engines for Sewage Treatment." — Address, Cooper-Bessemer Corp., Mt. Vernon, Ohio.

Bonded Seamless Rubber Tank Linings

A novel type of protective linings for tanks used to store and feed corrosive liquids such as ferric chloride or sulphuric acid is that developed by Collord, Inc., of Detroit, Mich.

The process involves the application of liquefied Special Collord Latex Compound by use of a spray-gun. The result is that a close bond between lining and tank walls is secured and any desired thickness of the seamless lining may be built up—

Collord Seamless Rubber Lined Ferric Chloride Storage Tanks

3/16ths inch being applied for ferric chloride tanks.

Collord, Inc., guarantees that such linings will adhere firmly, are proof against blister formation and, having no lapping or joints, are absolutely acid tight. The originators of this spraying lining process also claim that it is the most economical known method of producing rubber lined or rubber encased equipment and working parts. The job of lining is done quickly and with disregard for temperature conditions prevailing. Linings or coverings of the sprayed on Collord Latex Compound can be applied to any surface and to a variety of materials.

The above illustration pictures two 14x12 ft. Collord lined steel tanks for ferric chloride storage at the Dearborn, Mich., sewage treatment plant. For literature, more adequately descriptive of the Collord method of applying rubber linings and coatings—Address, Collord, Inc., 1430 Rosedale Ct., Dearborn, Mich.

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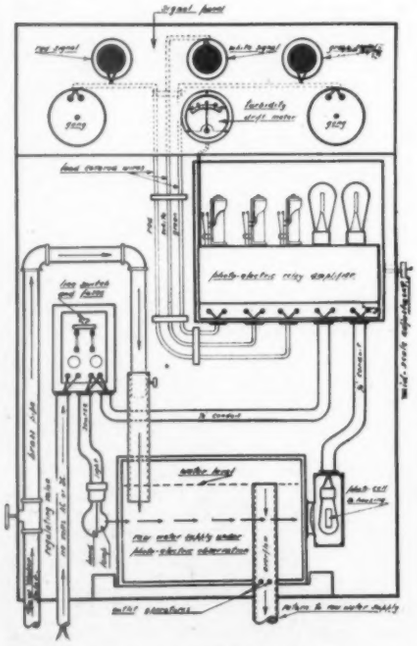
A Photoelectric Turbidicator

Most operators of modern filtration plants resort to periodical tests to determine the turbidity of the raw water supply. The Wayne Automatic Relay Company of Fort Wayne, Ind., has, on this account developed an instrument known as Photoelectric Turbidicator for such service.



Photoelectric Turbidicator

The Turbidicator offers an efficient method of phoelectrically keeping the raw stantly indicates any change in the turbidty of the raw water by an ingenious arrangement of signals.

In operation the instrument is "set" for the existing turbidity at which the coagulant is being applied, indicating a midscale zero reading on a sensitive meter. The continuous burning of a white light indicates no change in the turbidity. Should any change occur in the turbidity it will instantly be observed by the photocell and relayed to the signals. A red light and gong denotes an increase; a green light and gong denotes a decrease. The meter will show the drift in either condition.

The aging of the photocell, carbonization of the lamps or discoloration of the glass tank will have no effect upon its operation, according to the manufacturers. The instrument is designed for either AC or DC operation on 110 volts, is adaptable to any type filtration plant and can be operated with ease by non-technical operators.

For descriptive literature address Wayne Automatic Relay Company, Fort Wayne, Ind.

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Color Indexing Newest Thing for Valves

Color is an indexing device of proved value, having been employed in many ways to banish doubt and prevent errors and delays.

Jenkins Bros., widely known valve manufacturers, have recently developed a new line of "Valve Wheels in Colors" for special use on their valves, making it possible to identify valves on lines carrying steam, water, air, sludge, sewage, gas, etc., by the distinctive colors of their wheels. Five standard colors—blue, red, black, green and gray are offered, unmarked or with any one of five standard service markings. Jenkins also offers to make up wheels of special color or with special markings.

Write for the descriptive bulletin "Jenkins Colored Valve Wheels"—Address. Jenkins Bros., 80 White St., New York City.

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Catalogs and Trade Literature Received

Lawrence Pumps—The Lawrence Machine & Pump Corp., Lawrence, Mass., have issued its first bulletin since the company was taken over by Victor J. Mill, a long experienced designer and producer of pumps. The new bulletin (No. 201) thoroughly describes the construction of Lawrence Double Suction Horizontally Split Pumps and their applications; indicates the range of capacities and heads for the different sizes; contains several excellent installation views, and cuts showing details of construction and the overall dimensions for the different sizes. For Bulletin No. 201—Address, Lawrence Machine & Pump Corp., Lawrence, Mass.

Water Purification Chemicals—Their Practical Use—Is the cover title on a booklet of three reprinted article distributed by Pennsylvania Salt Manufacturing Company, in which is recounted Methods of "Handling Chlorine to Avoid Trouble"; "Handling and Storing of Water Works Chemicals"; "Coagulants Used in Water Purification, and Why." These articles have a practical value to operators and engineers and are based on experiences gained by plant operators and brought together by the author, L. L. Hedgepeth. Ask for "Water Purification Chemicals—Their Practical Use." Address Pennsylvania Salt Manufacturing Co., Widener Bldg., Philadelphia, Pa.

Conversion Factors for Engineers—The Dorr Company have reprinted, in convenient pocket size, their booklet of "Tables of Conversion Factors for Engineers." Originally prepared especially for use by Dorr Company engineers the demand created for the handy conversion tables and factors has resulted in a third printing. No charge is made for this very useful booklet, which may be had by addressing the Dorr Company, Inc., 247 Park Ave., New York City.

The Story of Boulder Dam—A profusely and attractively picturized "Story of Boulder Dam" comes from Ingersoll-Rand Company, which has supplied much of the air-compressing and drilling equipment used in the dam construction. Their latest issue (part 4) is worth having for its pictorial value as much as for descriptive methods of construction, concrete handling and cooling. Copies of Part 1, 2, 3 and 4 of the "Story of Boulder Dam" can be had by addressing Ingersoll-Rand Company, 11 Broadway, New York City.

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WITH THE MANUFACTURERS

Announcing the Cliffs-Dow Chemical Company

The Dow Chemical Company of Midland, Mich., and the Cleveland-Cliffs Iron Company of Cleveland, Ohio, announce that they have joined in organizing the Cliffs-Dow Chemical Company. The Cleveland-Cliffs Iron Co., producers of "Cliff-Char" activated carbon, has owned and operated a chemical plant at Marquette, Mich., for thirty years. The new company will specialize in the production of chemicals derived from wood and activated charcoal.

The officers of the Cliffs-Dow Company are as follows: Willard Dow, President; E. B. Greene, Vice-President; E. W. Bennett, Treasurer; V. P. Geffine, Secretary. Mr. E. T. Olson, the present manager of the Cleveland-Cliffs Iron Co. chemical plant at Marquette, has been made General Manager of the new company.

L.F.C.

AN EVERY-DAY JOB FOR "LYNCHBURG"

MIGHTY big fittings—sure—but then the Lynchburg Foundries are mighty big plants—backed by a mighty organization.

That's why "Lynchburg" has been able to standardize most of the so-called "specials"—assuring prompt, on time delivery.

Bell and Spigot Pipe and Fittings From 4" to 54"

Cast Iron Flanged Pipe From 3" to 84"

Cast Iron Flanged Fittings and Flanges from 1" to 84"

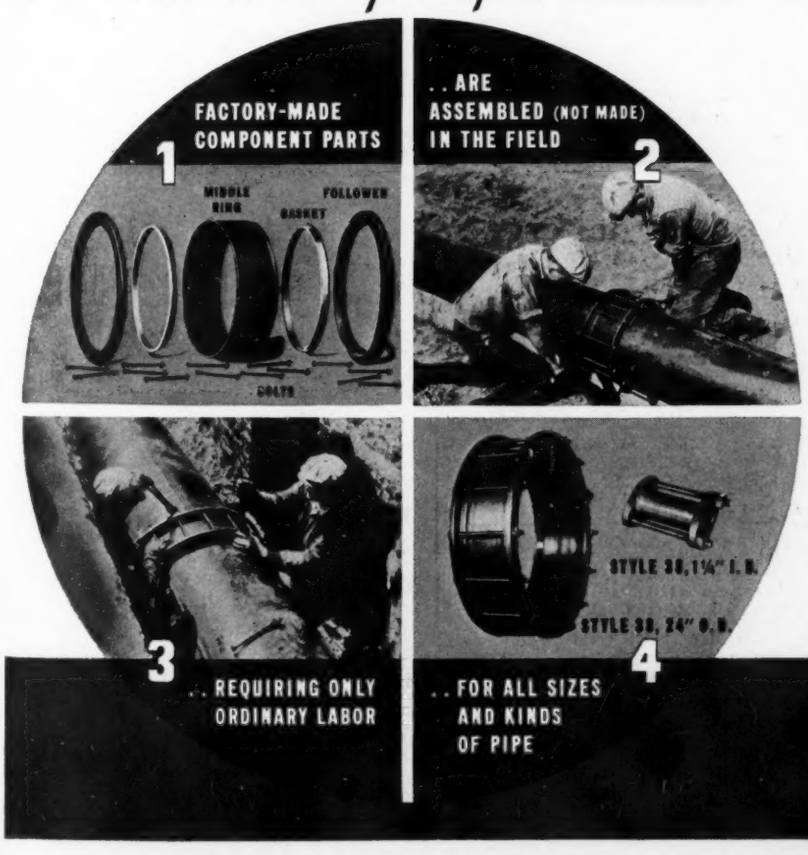
de Lavaud Centrifugal Cast-Iron Pipe

LYNCHBURG FOUNDRY COMPANY

General Office, LYNCHBURG, VA.

Peoples Gas Bldg., Chicago, Ill. Empire State Bldg., New York, N. Y.

Let Dresser Couplings SIMPLIFY YOUR PIPE-LINE WORK!



The easiest way to join two lengths of pipe is to Dresser Couple them. Most of the work is *done before you start,* for the Dresser parts (Photo 1) are simply assembled on plain-end pipe with just one tool—a wrench (Photo 2). This standardization *in the factory* eliminates the "human equation" in the field... permits the use of unskilled labor... makes every joint perfect regardless of weather, ditch water, assembly above or below the ditch, etc.

And that's not all! The completed Dresser joints will remain *permanently, absolutely tight* for the life of the line! Hence no "allowable leakage" need be figured, and no unaccounted-for losses occur! Yet Dresser Couplings are flexible enough to absorb all ordinary pipe movements!

These proved advantages can be yours by simply specifying *Dresser Couplings*—available for all sizes and kinds of plain-end steel and cast iron pipe. *Write for further information.*

S. R. DRESSER MFG. COMPANY • BRADFORD, PA.

DRESSER COUPLINGS

Belle Alkali Company

LIQUID CHLORINE — BRAND — CAUSTIC SODA

CHARLESTON, W. VA.

CHLORINE PRODUCTS

PLANT: BELLE, W. VA.

WE SPECIALIZE IN PURE WATER WORKS CHLORINE — WRITE FOR QUOTATIONS

LOCAL WORK for MORE LOCAL WORKERS

LOCAL labor is not only used for the laying but also for the manufacturing of Lock Joint Pressure Pipe, thus greatly relieving the local unemployment problem.

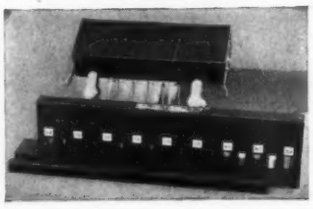
Lock Joint Pipe Co. Est. 1905. Ampere, N. J.

LOCK JOINT REINFORCED CONCRETE PIPE

PRESSURE - SEWER - CULVERT

pH SLIDE COMPARATORS

With a 5 YEAR GUARANTEE



This is a guarantee not carried by any other standards, whether liquid or artificial.

All comparators are molded from Bakelite and work on the slide principle.

Single Comparators $15.00. Water works set in wooden carrying case, covering range of 3 indicators, $40.00. Handbook, Modern pH and Chlorine Control, free on request.

W. A. TAYLOR & CO., Inc

871 Linden Ave., Balto., Md.

CIVIL ENGINEER—Graduate of the Rensselaer Polytechnic Institute, with a degree of Civil Engineer, age 22. Location immaterial. Desires engineering position with anyone interested. Available immediately. References. Address E. J. W., Water Works and Sewerage, 155 East 44th Street, New York City.

SANITARY ENGINEER—Age 27, married, B. S. in Sanitary Engineering. For past 5 years with a State Health Department. Experienced in operation of water supplies, water purification plants and sewage treatment works, swimming pool sanitation and stream pollution. Familiar with modern water works and sewerage practice. Desires change. Address S. E. K., care Water Works and Sewerage, 155 East 44th Street, New York City.

CIVIL ENGINEER; 1933 graduate of the Univ. of Illinois with M.S. in Sanitary Eng. Have 7 months' experience in building construction and drafting. Desire any permanent engineering position with opportunities of temporary position giving good experience. Age 23 years. Capable of hard work. Location immaterial. Wm. Hasfurther, 7723 S. Ada St., Chicago, Ill.

CHEMIST AND BIOLOGIST—Analytical Chemical Analyses, Biological examination of water for all purposes. Sewerage and industrial waste investigation and research. Age 34. 10 years' experience. D. E. Singer, 210 West 101st St., New York, N. Y.

POSITION WANTED—B.C.E. from recognized engineering school, '35. Age 23; single. Desires position in field of civil engineering. Location immaterial. References on character, etc., furnished at request. Available at once. Address G. S., % Water Works and Sewerage, 400 W. Madison St., Chicago.

POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

POSITION WANTED—As superintendent filtration, chemist and bacteriologist, or operator chemist and bacteriologist. Of small or medium sized plant. By young man technically educated, careful, industrious and ambitious for plant betterment. Eleven years' experience. May I have the opportunity of communicating with you. Address J. Z. C., Water Works and Sewerage, 400 W. Madison St., Chicago.

JUNIOR CIVIL ENGINEER—B.S. in C.E. Age 27, married; one year of experience in Surveying and Drafting. Passed civil service examination for assistant sanitary engineer. Desires position in sanitary engineering field. Location immaterial. Available at once. M. P., Water Works and Sewerage, 400 W. Madison St., Chicago.

CIVIL ENGINEER—Graduate (C. E.) Cornell University School of Civil Engineering, '34. Has specialized in sanitary engineering. Has had a little experience in design and drafting. Desires work of sanitary engineering type. Location and salary open. Available immediately. Address Peter T. Gavaris, 667 Teasdale Place, New York City.

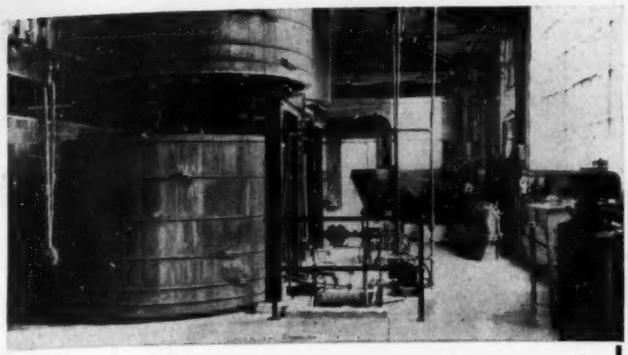
JUNIOR CIVIL ENGINEER — University graduate; single; age 26; seven months' drafting experience. Desires engineering position with civil or sanitary engineer, or with an engineering corporation. Salary and location open. Address "C. F. D.," % Water Works and Sewerage, 155 East 44th Street, New York City.

GRADUATE CIVIL ENGINEER—A.B. and C.E. in Water Supply and Sanitary Engineering, Stanford University '34. Member Sigma XI. Extensive research on chloramine sterilization. Age 26, single. One year experience structural design and surveying. Desires position in water supply or sanitary engineering field. Location immaterial. Reasonable salary with opportunity for advancement. Address N. J. K., % Water Works and Sewerage, 155 East 44th Street, N. Y. C.

GRADUATE CIVIL ENGINEER, Univ. Michigan, 1932, specializing in Sanitary Engineering. Age 25. Experience as assistant in sanitary inspection of water supply, analysis sewage and sewage gas, determination source of odors in sewer system, gaging of sewers and streams. Now conducting independent research on sewage and garbage. For references and further information address G. W. H., % Water Works and Sewerage, 155 East 44th Street, New York City.

GRADUATE CIVIL ENGINEER—B.S. in Civil Engineering, Michigan College of Mining and Tech., '34. Specialized in Hydraulics. Enthusiastically interested in Sewage Disposal and Sewerage problems. Age 23, single. Employment under recognized authority preferred. Available immediately. Address L. P. M., Water Works and Sewerage, 400 W. Madison St., Chicago.

WATER WORKS SUPERINTENDENT—With ten years' experience and last three years Superintendent Water Works at Vidalia, Ga., desires change. Prefers Southern State. Available July 1st. References as to character, ability and competency supplied upon request. 38 years of age; married and family of six. Address L. E. K., Water Works and Sewerage, 155 East 44th St., New York City.



SCENE ONE

After the raw greensand has been dug . . . the first act, in processing it into zeolite, is to wash it. Permutit takes its own medicine and first *cleanses the water* by coagulation, filtration, and chlorination before the water is used to cleanse the zeolite.

Cleansing, screening, and treating are *all* carefully controlled by constant testing in the rigorous processing that produces Zeo-Dur and Super-Zeo-Dur, the tough mineral granules produced from raw greensand. That's what makes these the finest zeolites you can buy.

Write us for complete details of these or other zeolites. Permutit makes a whole family of them. The Permutit Company, 330 West 42nd Street, New York City.

Permutit
Water Conditioning Equipment

ANTHRAFILT

An Improved Filtering Medium

●

Anthrafilt will give a higher percent removal of bacteria and turbidity than will sand of the same size. Therefore, coarser filter media can be used with all of the attending advantages.

Anthrafilt is particularly well adapted to swimming pool filters because of its ability to remove coarse material, such as hair, etc., from the swimming pool water.

Inquiries invited and samples furnished.

●

THE HUDSON COAL CO.
SCRANTON, PA.

G. B. FILLMORE
General Sales Agent

LACKAWANNA "the Diff." ANTHRACITE

H. H. SHAVER
Asst. Gen. Sales Agent

CALIFORNIA
saves Trouble and Money
...in WATER PIPE JOINTING!

THE East Bay Municipal Utility District serves a large number of cities and towns — including Oakland, Berkeley, Alameda, Richmond, etc.—on the east side of San Francisco Bay.

From 1930 to the present time this District has laid more than one hundred miles of cast iron bell and spigot water pipe with MINERALEAD joints.

This pipe has ranged in diameter from six to sixteen inches and includes one continuous job of 175,000 feet.

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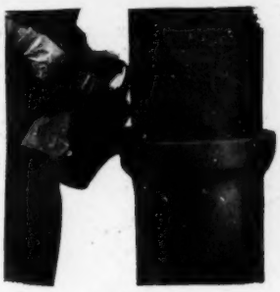

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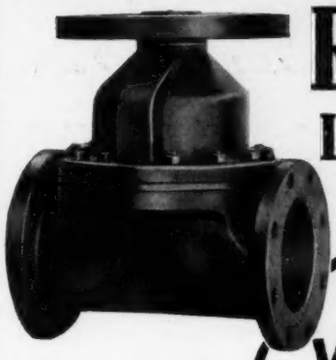

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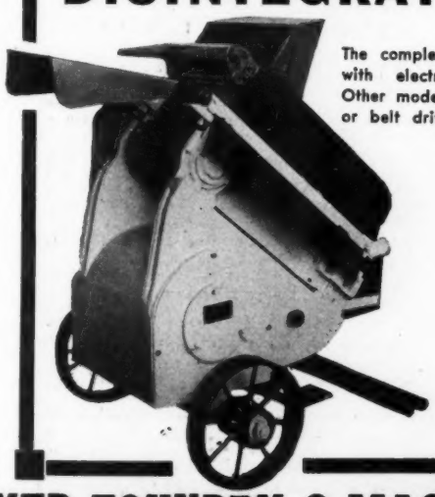

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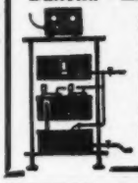

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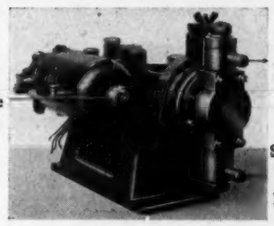

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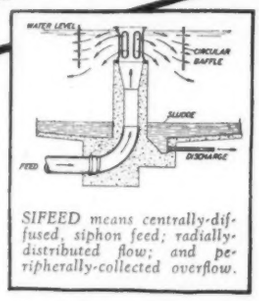

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